GREAT AUSTRALIAN BIGHT MARINE PARK

MANAGEMENT PLAN

PART B - RESOURCE INFORMATION

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Abbreviations

The following abbreviations are used in this document

ACIUCN	Australian Committee for the International Union for the Conservation of Nature and Natural Resources
ATSIC	Aboriginal and Torres Strait Islander Commission
CONCOM	Council of Nature Conservation Ministers
DEHAA	Department for Environment, Heritage & Aboriginal Affairs
GABMP	Great Australian Bight Marine Park
IUCN	International Union for the Conservation of Nature and Natural Resources - now known as the World Conservation Union
NPWSA	National Parks and Wildlife South Australia
PIRSA	Primary Industries & Resources South Australia (including Mines & Energy)
SARDI	South Australian Research and Development Institute
SATC	South Australian Tourism Commission

Acknowledgements

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Other people have contributed to this Management Plan:

- input and advice was received from the Great Australian Bight Marine Park Management Plan Advisory Committee
- considerable advice was received from staff of PIRSA (Fisheries)
- many submissions from the fishing industry, conservationists and the general public contributed ideas and stimulated the discussion of issues
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INTRODUCTION

Conservation intiatives in the Great Australian Bight region were first recognised with the proclamation under the *Fisheries Act 1982* of the Great Australian Bight Marine Park Whale Sanctuary at the Head of the Bight in June 1995. In September 1996 the Great Australian Bight Marine National Park was proclaimed under the *National Parks and Wildlife Act 1972*. These two areas comprise the Great Australian Bight Marine Park and are shown in Figure 1; the Management Plan applies to both these areas.

The Management Plan for the Great Australian Bight Marine Park consists of two parts.

Part A includes the Management Prescriptions and the objectives and strategies which support them. It describes the activities which are permitted in the Marine Park and what management provisions will be in place to facilitate those activities. **Part A** will be the legally adopted section of the plan.

Part B includes detailed descriptions of the Park and contains information about the resources of the area. It is a valuable reference document for all those who have an interest in marine ecosystems, the natural history of the Great Australian Bight and the challenges associated with managing for multiple use. Readers of both documents may find that some information has been duplicated although an effort has been made to keep this to a minimum.

This document is **Part B**; its features are

- detailed descriptions of the region
- a glossary to explain technical terms
- a comprehensive bibliography.

1 THE GREAT AUSTRALIAN BIGHT

The Great Australian Bight region has many features of interest to marine ecologists. Not only has the region very high levels of marine biodiversity and endemism, particularly of sea squirts, bryozoans, molluscs and echinoderms (Shepherd 1991, Poore 1995), but the region is also becoming recognised as an area of global conservation significance for species of rare and endangered marine mammals (Edyvane 1996b).

The southern coast of Australia, from Tasmania to Cape Leeuwin, is the longest stretch of south facing coastline in the Southern Hemisphere and has been subject to a long period of geological isolation. As a consequence, it is a region of high marine biodiversity and endemism, unparalleled in other coastal marine environments around Australia (Edyvane 1996b). The seasonal influence of the Leeuwin Current (Rochford 1986) and the localised periodic cold water, nutrient-rich upwellings in the eastern Great Australian Bight (Kitani 1977), have also contributed to the marine biodiversity and productivity of the region. In particular, the warm waters of the Leeuwin Current are thought to be responsible for the dispersal of many pelagic marine organisms from the warm waters of the north-west of Australia to the southern seaboard (Maxwell & Cresswell 1981).

Localised periodic nutrient-rich upwellings of cold water have been identified in the Great Australian Bight, off the coast of western Eyre Peninsula (from Baird Bay to western Kangaroo Island). The upwellings are characterised by an ephemeral temperature inversion within the shelf waters, south of Eyre Peninsula, during October and November (Kitani 1977). These upwellings, by providing nutrients to surface waters, are sites of significant biological productivity. Recent studies have indicated a close relationship between these upwellings and pilchard abundance in the region (SARDI, *unpubl. data)*.

Against the waters of the Great Australian Bight, the adjoining Nullarbor Plain region is one of equal national and international cultural and conservation significance (Cane & Gara 1989). The cliffs and dunes at Head of Bight are recognised as a Geological Monument by the Geological Society of Australia (SA Division). From here the Nullarbor Cliffs (or Bunda Cliffs) which average 80 metres in height, stretch unbroken for 209 km to Wilson Bluff (another listed Geological Monument) at the Western Australian border (Fotheringham 1994). These spectacular steep Tertiary limestone cliffs provide some of the best coastal wilderness scenery in Australia. After 179 km of unbroken cliff line, the last 30 km to the border, has been partly transgressed by Holocene dunes which have overtopped the high cliffs, building the extensive Merdayerrah Sandpatch.

The highly variable coast of the Great Australian Bight provides a variety of habitats for marine life; there are many islands, rocky headlands, embayments and surf pounded beaches (Short *et al.* 1986). This variability is a result of the continual changes in orientation and degree of protection of the coast from wave attack. The generally low summer rainfall coupled with a limestone (calcarenite) dominated coast has resulted in no rivers or streams arriving at the coast. As a result there are no true estuarine environments along the Great Australian Bight.

Large coastal embayments, with extensive seagrass meadows, occur predominantly at the eastern end of the Bight. Open bays with broad entrances but protected by islands, reefs and shallow gradients include Coffin Bay, Sceale Bay, Streaky Bay, Smoky Bay, Décres Bay and Denial Bay. Open bays that are largely protected by sand barriers with only narrow inlets or entrances occur at Port Douglas, Venus, Baird and Tourville Bays (Short *et al.* 1986). These bays contain extensive tidal delta deposits. Smaller bays include the area in lee of Cape Missiessy and Acraman Creek. In some coastal areas, numerous saline lakes have formed in lee of many of the sand barriers (such as the Lake Newland barrier, Sheringa and Cactus Beach). These lakes form because of a lack of fluvial input, periodic freshwater flooding and high evaporation rates.

Offshore islands and numerous reefs scattered within the Great Australian Bight include the Recherche Archipelago (WA) and Nuyts Archipelago (SA) and the Investigator Group of Islands.

1.1 Why a Marine Park for the Great Australian Bight?

Conservation status of marine areas

Despite the level of marine biodiversity and endemism along the southern coast of Australia, the management of ecosystems, habitats and species of this coast, in particular the Great Australian Bight, is under-represented in terms of marine protected areas. As of 1991, nearly 39 million hectares (or 5%) of Australia's waters (comprising States, Territories, External Territories and Commonwealth waters) has been reserved in approximately 250 Marine Protected Areas (Hooy and Shaughnessy 1992, Bridgewater and Ivanovici 1993). Of this total reserved area, approximately 88% is in the Great Barrier Reef region, leaving many regions particularly temperate ecosystems, poorly or under-represented (Bridgewater & Ivanovici 1993).

Prior to June 1995, a total of only 236 ha within the 18.6 million hectare biogeographic zone of the Great Australian Bight had been formally reserved as Marine Protected Areas (Ivanovici 1993). Most of this area was the Point Labatt Aquatic Reserve (230 ha) on the west coast of Eyre Peninsula, established specifically for the protection of a breeding colony of the Australian Sea Lion. There is no public access to this reserve.

Box 1 Marine Protected Areas

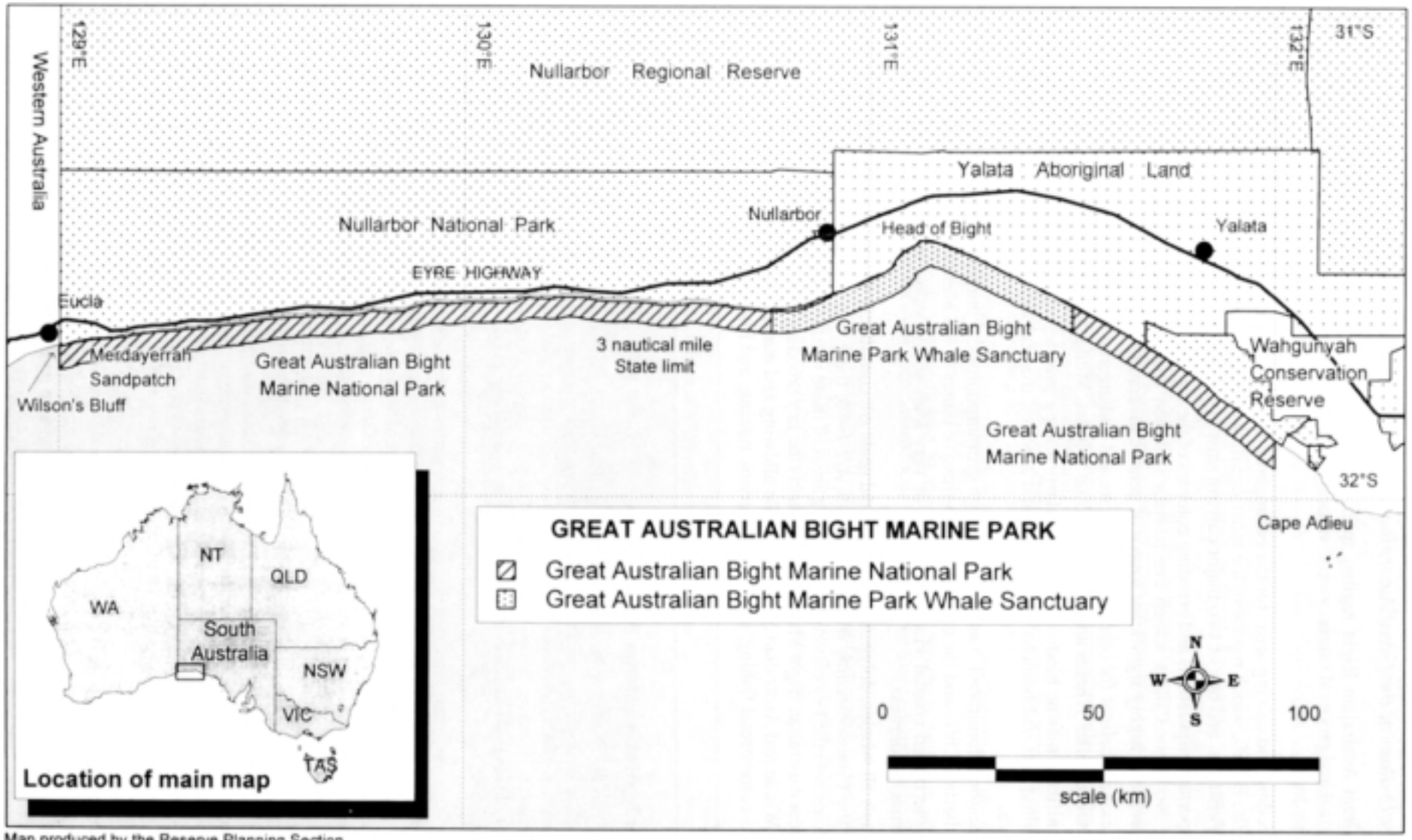
The establishment of Marine Protected Areas is widely regarded, both nationally and internationally, as one of the most effective mechanisms for protecting marine biodiversity while permitting the sustainable use of natural resources. As an island continent, Australia has a diverse range of coastal, marine and estuarine environments. These range from the tropical ecosystems of northern Australia (coral reefs and tropical mangrove forests), to the cool temperate ecosystems in the south (kelp forests and deep-water sponge beds). Australia has a maritime area larger than the continent itself (ie 894 million hectares), and is a signatory to international conventions like the *Convention on Biological Diversity* (UNEP 1992). Australia has a special responsibility for the conservation and management of its marine and coastal environments and their resources and is presently regarded as a world leader in marine conservation and management.

Marine Protected Areas in Australia range from small, high protection Marine Reserves, to large, multiple-use Marine Parks (like the Great Barrier Reef Marine Park) which permit a wide range of exploitative uses, such as fishing (commercial and recreational), tourism and recreation. Marine Protected Areas can be established for a variety of purposes and it is possible to provide for a range of activities while still protecting the environment. For example, Marine Protected Areas can be reserved for conservation, fisheries management, research, education, social and historical importance, tourism or recreational use - or a combination of any of these - and may also include neighbouring coastal lands and islands. Marine Protected Areas are defined as:

> any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.'

To 1995, nearly 46 million hectares (or 5%) of Australia's waters (comprising States, Territories, External Territories and Commonwealth waters) have been reserved in approximately 304 Marine Protected Areas. Of this total area reserved as Marine Protected Areas in Australia, approximately 89% is in the Great Barrier Reef region - leaving many regions, particularly temperate ecosystems, poorly or under represented, if at all. A 1993 study estimated that 21 out of the 32 biogeographic regions around Australia lack any significant protection as protected areas (Ivanovici 1993), including, at that time, the Gulf of Carpentaria, the Great Australian Bight and deep offshore regions.

Thus the Great Australian Bight Marine Park is an important addition to a State, national (and international) network of Marine Protected Areas and represents the first formal reservation and management of the marine habitats and ecosystems typical of the southern coast of Australia.



Map produced by the Reserve Planning Section,
Natural Resources Group, DENR
Map projection is AGD66 in decimal degrees

Figure 1: Planning area for the Great Australian Bight Marine Park

Natural values of the Great Australian Bight

The Great Australian Bight region, specifically the area adjacent to the Nullarbor Cliffs, has biological and physical resources and values which are of international and national significance. They include:

- breeding and calving areas for the endangered Southern Right Whale (particularly at the Head of the Bight), which represent the most significant breeding and calving areas for this species in Australia, and one of two major calving sites in the world;
- important populations and breeding colonies of the rare Australian Sea Lion (particularly along the Nullarbor Cliffs), which due to their isolation and probably negligible rates of sealing represent a highly significant source of genetic diversity for the species;
- a seasonal habitat for other species of rare and endangered marine mammals including Sperm Whales, Killer Whales and Rorquals (Blue Whales, Minke Whales and Humpbacks);
- significant marine biodiversity, particularly among invertebrate fauna (such as ascidians [sea squirts] and nudibranchs [sea slugs]) and a warm, tropical element in the marine fauna and flora;
- limestone-dominated coastal areas of high geomorphological interest, including the spectacular Nullarbor Cliffs and the extensive transgressive dunes of the Merdayerrah Sandpatch;
- uninterrupted coastal vistas and areas of very high scenic value in a remote and relatively pristine wilderness.

Although all whales, dolphins, porpoises and seals are completely protected in Australian waters under the *Commonwealth Whale Protection Act 1980*, there is a world-wide recognition of the need to protect the key calving and breeding areas of these marine mammals. The establishment of the Great Australian Bight Marine Park protects the key breeding and calving areas of the Southern Right Whale and Australian Sea Lion, while allowing and managing a range of human activities, such as commercial fishing, recreation, tourism, mining, and research.

Box 2 What is a Marine Park?

The concept of Marine Parks is one of managed use within a conservation framework. Marine Parks are large, multiple use areas that attempt to integrate the management of a range of activities (such as commercial and recreational fishing, recreation, tourism and mining) by providing for varying levels of protection and use throughout the area. The principal aim of a Marine Park is not to exclude use but to manage all activities and uses in the area on an integrated, ecosystem level for ecologically sustainable use.

The integrated management of uses or activities within a Marine Park is achieved through a process of zoning. Zoning separates a Marine Park into discrete management units or zones and provides levels of protection which reflect the characteristics of natural resources, biodiversity and traditional use. Most importantly, by separating potentially conflicting uses and activities into different areas or zones, zoning minimises conflicts that may arise between the different user groups.

The zoning of activities or uses within a Marine Park is determined with community and industry participation through the development of a management plan.

One of the best known examples of a multiple use Marine Park is the Great Barrier Reef Marine Park, which provides for a range of activities, such as tourism, fishing (commercial and recreational), conservation, recreation and scientific research, while maintaining the essential ecological processes which sustain this coral reef ecosystem. Only a small proportion of this well known Marine Park (approximately 5% in area) is totally excluded from exploitative activities, such as fishing, for preservation purposes.

An integrated approach to marine management should extend to coordinated management of marine and adjacent terrestrial areas, into the coastal zone and beyond. The Management Prescriptions in Part A suggest that such an integrated approach to the management of the Great Australian Bight Marine Park be achieved through agreements with other relevant government agencies and stakeholder groups.

Protection of these natural values by means of the Great Australian Bight Marine Park will give direct and indirect benefits to South Australia including:

- national and international recognition for the protection of globally significant breeding and calving areas of the Southern Right Whale and also, the recently recorded breeding colonies of the Australian Sea Lion;
- a significant contribution to the national, representative system of Marine Protected Areas (see Box 3), which will represent the first formal reservation of the marine habitats and ecosystems typical of the southern coast of Australia;
- a multiple-use management area where economic activities, such as commercial and recreational fishing, mining and the developing ecotourism industry can be cooperatively managed on an ecologically sustainable basis;
- increased regional and state ecotourism opportunities and recognition through the management of some of the best whale-watching opportunities in the world;
- opportunities for involvement of indigenous communities in Marine Park management and training, particularly whale-watching activities and ranger training;
- a focus for marine education and interpretation of the marine environment for the isolated remote communities of the far West Coast of South Australia;
- the establishment of South Australia's first Marine Park, which has the potential to provide a major national and international ecotourism focus and asset for the State (particularly, the Eyre Peninsula region);
- a continuing focus for the ongoing internationally recognised scientific research on the behaviour and biology of the Southern Right Whale (which is comparable with the national and international interest in Great White Shark research conducted in South Australian waters).

Box 3 A national representative system of Marine Protected Areas

While reserve systems in Australia have been in place for terrestrial ecosystems for many decades, the formal conservation of Australia's marine environments and their resources is a relatively recent phenomenon - with only 4.1 per cent of Australia's coastal, estuarine and marine habitats formally reserved as Marine Protected Areas (or MPAs). However, in November 1990 Prime Minister Bob Hawke announced at the International Union for the Conservation of Nature (IUCN) General Assembly in Perth, that:

> *'the Australian Government has decided to work towards the expansion of Australia's marine reserve system. In association with the State and Territory governments, we will investigate the establishment of a national, representative system of marine protected areas for Australia that will protect these areas, while permitting appropriate uses and promoting public education.'*

Following the Prime Minister's announcement, the Federal Minister for the Arts, Sport, Environment and Territories, the Hon Ros Kelly MP, announced the initiation of a 10 year marine conservation program, called 'Ocean Rescue 2000' to ensure the conservation and sustainable use of Australia's marine and estuarine environments and their resources. A key objective of this program is the establishment of a national, representative system of MPAs. In addition to fulfilling objectives 2.1 and 10.1 of the *National Strategy for Ecologically Sustainable Development (1992)*, and objective 1.4 of the *National Strategy for the Conservation of Australia's Biological Diversity (1996),* the representative system of MPAs will also reflect the responsibilities and obligations of various international strategies, conventions and treaties, such as the *Convention on Biological Diversity (UNEP 1992*).

The objective of the Ocean Rescue 2000 program for a national, representative system of MPAs is:

> 'to develop and implement, in association with the States, Territories and the Commonwealth, a national representative system of Marine Protected Areas by the year 2000, as a contribution to sustainable use of marine environments.'

continued over

Box 3 continued

Through the program and the National Advisory Committee on Marine Protected Areas, the Commonwealth Government is working cooperatively with State and Territory governments to expand the existing system of Marine Parks and Reserves, to conserve the range of Australia's coastal and marine biodiversity, while allowing sustainable uses, including traditional use by Aborigines. Elements of a national representative system of MPAs already exists in the form of large, multiple-use Marine Parks such as the Great Barrier Reef Marine Park (Qld) and Ningaloo and Shark Bay Marine Parks (WA). In this way, representative or typical examples of the full range of Australia's marine and coastal biodiversity from coral reefs to estuarine environments, and from tropical waters to cold southern waters, will be managed and protected, while allowing a range of appropriate sustainable uses, such as fishing (commercial and recreational), tourism, recreation and mining.

The national Marine Protected Areas program is presently administered by the Department of Environment, Sport and Territories, through the Biodiversity Group of Environment Australia and the Great Barrier Reef Marine Park Authority.

1.2 Regional Setting—adjoining lands

Three parcels of land abut the Great Australian Bight Marine Park: the Nullarbor National Park and Wahgunyah Conservation Reserve, both managed by the Department for Environment, Heritage & Aboringal Affairs and the Yalata Aboriginal Land Lease (managed by the Yalata Aboriginal Community Incorporated) (see Figure 1). The land adjacent to the Marine Park is presently outside the jurisdiction of local councils. The nearest local council area is the District Council of Ceduna.

While this draft Management Plan refers only to the Marine Park, in due course it is desirable that State agencies and local stakeholder groups manage the Great Australian Bight Marine Park and the adjacent coastal lands as an integrated coastal-marine region using the resources of DEHAA, PIRSA (Fisheries), the Aboriginal Lands Trust and Yalata Community. Appropriate management agreements will be necessary.

Nullarbor National Park

The Nullarbor National Park protects part of the world's largest semi-arid karst (limestone) landscapes. The park encompasses 593 000 ha and is a vast area of low open woodland, the treeless karst plain comprising a portion of the park. The principal vegetation communities consist of mallee and dry land tea-tree, with saltbush and bluebush communities.

Yalata Aboriginal Lease Land

The Yalata Aboriginal Land Lease is held in trust for the Yalata Council by the Aboriginal Lands Trust of South Australia. The Yalata lands cover a total of 456 000 ha stretching from Coorabie in the east to the Head of Bight in the west. This portion of land abuts the Marine Park immediately adjacent to the critical breeding and calving areas at the Head of the Bight (see Figure 1).

In 1952 this land was purchased by the South Australian Government and the Lutheran Church for resettlement of the Pitjantjatjara from Ooldea mission and Yalata and Pitjantjatjara people displaced by the Maralinga and Emu atomic bomb tests. In 1975 the land was leased on a freehold basis to the Yalata Community Incorporated. This lease is presently administered by the Aboriginal Lands Trust.

Wahgunyah Conservation Reserve

Very little resource information is available on this section of the land abutting the eastern end of the Marine Park. The Wahgunyah Conservation Reserve is 15 555 ha in area and is designated a Conservation Reserve under the Crown Lands Act and it is managed for nature conservation.

2 PHYSICAL FEATURES

2.1 Climate

The coastal area of the Nullarbor has a winter rainfall and a semi-arid climate; its interior has an arid climate with a uniform rainfall distribution. Occasional heavy rainfalls occur in mid to late summer from the remnants of tropical cyclones, but these events are exceptions. While a seasonal pattern of rainfall can be discerned along the Nullarbor coast, rainfall overall is very variable.

The climate of the Eyre Peninsula coast to the east of the Bight is typically semi-arid or Mediterranean and is characterised by hot, dry summers and cool, moist winters. It is largely influenced by mid-latitude anticyclones or high pressure systems which pass from west to east across the continent. Winter generally brings southerly to south-easterly winds and low pressure systems which travel across the Southern Ocean between 40 and 50°S, bringing frontal activity and rain. Summer brings northerly to north-westerly winds. Along the Great Australian Bight and the western coast of Eyre Peninsula, strong westerly, onshore winds have reworked the coast, resulting in extensive dune development.

Most rain falls during winter, however it varies considerably with latitude, from approximately 500 mm in the south to less than 300 mm in the north.

The townships of Eucla and Ceduna, on the far west Eyre coast, receive an annual average rainfall of 257 mm and 315 mm respectively, with the greatest proportion falling during winter.

Mean monthly maximum temperatures on the coast range from 26° in January to 18° in July at Eucla and from 28° in January to 17° in July for Ceduna.

2.2 Bathymetry

The extensive shallow continental shelf is a key bathymetric feature of the Great Australian Bight (see Figure 2). Along the southern margin of the Australian continent, the shelf is broadest in the Bight (as much as 300 km in width) and narrows to about 25 km width to the east and west (Willcox *et al.* 1988). In the west of the Great Australian Bight, near Esperance (WA), the shelf, known as the Eucla Shelf forms a large arcuate plain with a maximum width of 300 km to the east of Eucla. Farther eastwards, the width of the shelf varies from 50 to 200 km, while in the extreme southeast it narrows to about 20 km. The outline of the continental slope is broken by a major terrace (Ceduna Terrace) and two minor terraces (Eyre and Beachport Terrace) (see Willcox *et al.* 1988). The Ceduna Terrace is a sigmoidal shaped feature, up to 130 km wide and 600 km long, and is located between 1000-2500 m and is dissected by numerous submarine valleys (James *et al.* 1994). The Eyre Terrace lies at depths of 400-1600 m.

The continental shelf is almost featureless, forming a gently sloping plain out to the shelf break at about 125-165m depth. Minor changes in slope also occur at about 25 m and 90 m depth. The shelf on the eastern side of the Great Australian Bight has been extensively modified by the Pleistocene outlets of the Murray River. Within the boundaries of the Great Australian Bight Marine Park, depths rarely exceed 20 m, east of the Head of Bight, but increase to 40 m depth, westwards along the Nullarbor Cliffs (see Figure 2).

The bathymetry of the Great Australian Bight region has been described by Connolly and von der Borch (1967), Connolly *et al.* (1970), Willcox (1978), and Willcox *et al.* (1988), while a detailed bathymetric map of the Ceduna Terrace has been compiled by Tilbury and Fraser (1981).

The wide, swell-dominated, open shelf waters of southern Australia, particularly the Otway region of southeastern South Australia (Lacepede and Bonney Shelf) and western Victoria (Otway Shelf) and Great Australian Bight (Eucla Shelf), have also allowed some of the largest modern, cool-water, open shelf accumulations of carbonate sediments in the world (Connolly & von der Borch 1967, Wass *et al.* 1970, Gostin *et al.* 1988, James & von der Borch 1991, James *et al.* 1994). Export of sediment from the continent to the wide continental shelf is low because of the low continental relief and a predominantly arid climate. Together with the cold water upwelling ocean waters, this has resulted in luxuriant growths of carbonate-producing bryozoans and coralline algae, together with sponges, molluscs, asteroids, benthic and some planktonic foraminifera. These organisms form the basis for the accumulation of Holocene sediments, which generally contain a

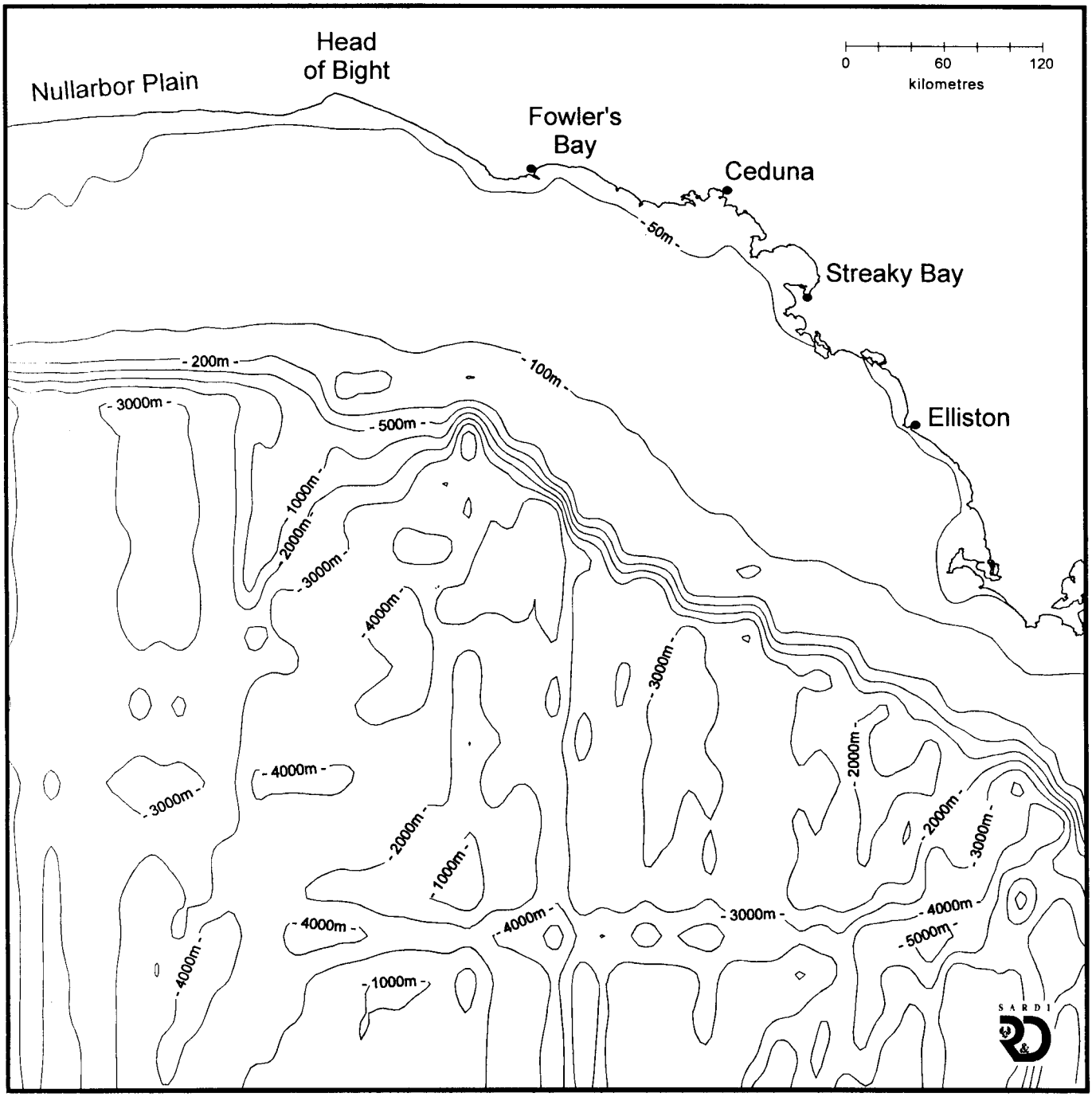


Figure 2: Bathymetry and features of the continental shelf of the Great Australian Bight (SARDI *unpubl. data).*

high proportion of bryozoans. In open coastal areas, like the Great Australian Bight, winds and persistent south-west swells, erode and rework these contemporary sediments and older calcrete-encrusted Pleistocene aeolianites (Gostin *et al*. 1988).

The Holocene carbonate sediments of the Eucla Shelf, are dominated by coralline algae and conspicuous large foraminifera (e.g. *Marginopora)* and depleted in bryozoans, in contrast, to the Lacepede and Otway Shelf, where bryozoans dominate the shelf sediments (James *et al.* 1994). This is largely due to the influence of the warmer waters of the Leeuwin Current and downwelling off the Eucla Shelf, in contrast to the cooler water and upwellings off the Lacepede and Otway Shelf.

2.3 Oceanography

The oceanography of the Great Australian Bight is typified by a moderate to high deepwater wave energy coastline, with no true rivers, but a few intermittent streams. During the summer months (February - March), the warm waters of the south-west coast of Eyre Peninsula (from Baird Bay to western Kangaroo Island), are subject to localised, seasonal, cold, nutrient-rich coastal upwellings.

Tides along the western Eyre coast are microtidal in range and are predominantly semi-diurnal with a marked diurnal inequality between the two daily tides. Tides in the Great Australian Bight (western Eyre Peninsula) are semi-diurnal, with a mean tidal range of between 0.8 and 1.2 m.

Wave climate

The Great Australian Bight is located within the 'west coast swell environment' where coastal processes are dominated by a persistently high southwest swell, generated by the westerly moving low pressure cyclones south of the mainland. This south-west to westerly swell ranges from less than 2 m for 50% of the year, to 2 - 4 m for 30 - 45% of the year and exceeding 4 m approximately 10% of the year. Wind generated sea conditions also provide an additional source of wave energy, with seas averaging 0.5 to 1.25 m and may exceed 2 m for 10 - 15% of the year.

Breaker wave energy varies considerably along the western Eyre Peninsula coast. Land-locked bays and sheltered areas, such as Venus Bay, experience low breaker wave energy with local wind waves influencing energy regimes. The open coast, however, is typified by a high deepwater wave climate and a highly variable breaker wave climate due to differences in nearshore - offshore gradients.

Water temperature and salinity

Open coast sea temperatures in the Great Australian Bight vary from a mean summer sea surface temperature of 18°C to a mean winter sea surface temperture of 14°C (decreasing to 11 - 12°C under the influence of upwellings). Water temperatures (and salinities) vary markedly within shallow coastal embayments and other sheltered areas in the eastern Bight region.

Generally, high salinity is a feature of the Bight, with levels of 35.7 % being recorded at 100 m depths (Rochford 1980). These waters which form a reservoir for the supply of surface waters are also generally deficient in nutrients, like most Australian surface waters. In the case of the Bight, this is due partly to the isolation from the rich sub-Antarctic waters to the south and partly to the lack of riverine input.

Open coast salinities and water temperatures along the coast of the Great Australian Bight generally vary according to the water masses that prevail in the Bight region. These water masses generally occur for all or part of the year within the continental shelf and slope region off southern Australia.

Currents

Four major water masses or currents influence the oceanography of the Great Australian Bight region (see Figure 3).

- the Leeuwin Current, which has low salinities (35.0%) and high temperatures. This water mass, which originates from the tropical waters of the Indian Ocean, carries warm water with low salinity along the continental shelf break as far east as 130°E and passes from west to east

predominantly (though not exclusively) during winter from May to September-October (Rochford 1986). However, it is possible there is a reversal of flow in the summer with the current setting to the west along the south coast and to the north on the west coast (Rochford 1969).

- the central Bight water mass from the southeast Indian Ocean, which has high salinities (35.4 - 36.0%), and warmer temperatures (17 - 21°C). This warm and very high salinity water mass, occurs in the central and eastern half of the Great Australian Bight for most of the year, and drifts to the southeast and occupies much of the shelf and slope region east of 135°E, particularly in winter (Rochford 1986). Petrusevics (1991) observed that, during winter, an isolated and large pool of water is formed in the central offshore region of the Bight, and this pool moves easterly in August-September.
- the West Wind Drift cold water mass, which has low salinities (35.0%-35.6%) and lower temperatures (9 - 14°C). This cold water mass of lowest salinity, is found throughout the year off the slope region of southern Australia and periodically intrudes into the shelf break, especially when the Leeuwin Current is weakly developed (Rochford 1986).
- and the surface-flowing Flinders Current, which has a mean salinity of 35.35% and a mean temperature of 14°C. This water mass originates from the gyre south of South Australia (Bye 1972). These mixed waters have an average surface flow velocity of approximately 5cm sec^{-1}.

Advective processes influence and control the salinity distribution across, and within, shelf waters. Some additional mixing is brought about by the reversal in direction of a easterly-south-easterly flow in winter, to a westerly-north-westerly flow during November to March. During summer and early autumn the region is characterised by a pool of warm (21 - 22°C) water in the northwestern sector of the Great Australian Bight (Petrusevics 1991). The warmer coastal water is flanked by cooler (18 - 19°C) offshore shelf water. In the winter an eastwest aligned tongue of water (20°C) water is located on the shelf, midway between the coast and the shelf break, and it is surrounded by marginally cooler coastal water (19°C) (Petrusevics 1991).

With regard to the vertical structure of the water column, in summer the water is stratified with a well defined near mid depth temperature and salinity discontinuity. By winter, this stratification is eroded and the water column is near homogeneous in terms of temperature and salinity.

Upwellings

Localised periodic cold water, nutrient-rich upwellings have been identified off the coastal regions of the eastern Great Australian Bight (from Baird Bay to western Kangaroo Island) (Wenju *et al* 1990). These upwellings, by providing nutrients to surface waters, are sites of significant productivity. Recent studies have indicated a close relationship between these upwellings and pilchard egg abundance in the region (SARDI, *unpubl. data.*).

2.4 Geology and Geomorphology

Geology

The coast of the Great Australian Bight consists of an ancient bedrock geology overlaid by younger Cainozoic, Tertiary and Quaternary deposits (see Parker *et al*. 1985 for overview). Major rock and sediment types along the Eyre coast include:

- Tertiary chalky and crystalline limestones which are exposed continuously from Twin Rocks to the Western Australian border;
- Pleistocene dune calcarenite (dune rock) which occurs extensively from Port Lincoln to Twin Rocks; and
- Holocene marine and aeolian sands and occasional mangrove peats are scattered along the whole length of the coast.

The offshore geology of the great Australian Bight is dominated by three sedimentary basins of varying significance—namely, the Bremer Basin (south of the Yilgarn Block, south-west WA), the Great Australian Bight Basin (with the associated Eyre Sub-basin, Polda Trough and Duntroon embayment), and the Otway Basin (on the eastern side of the Great Australian Bight to Bass Strait (Willcox *et al.* 1988).

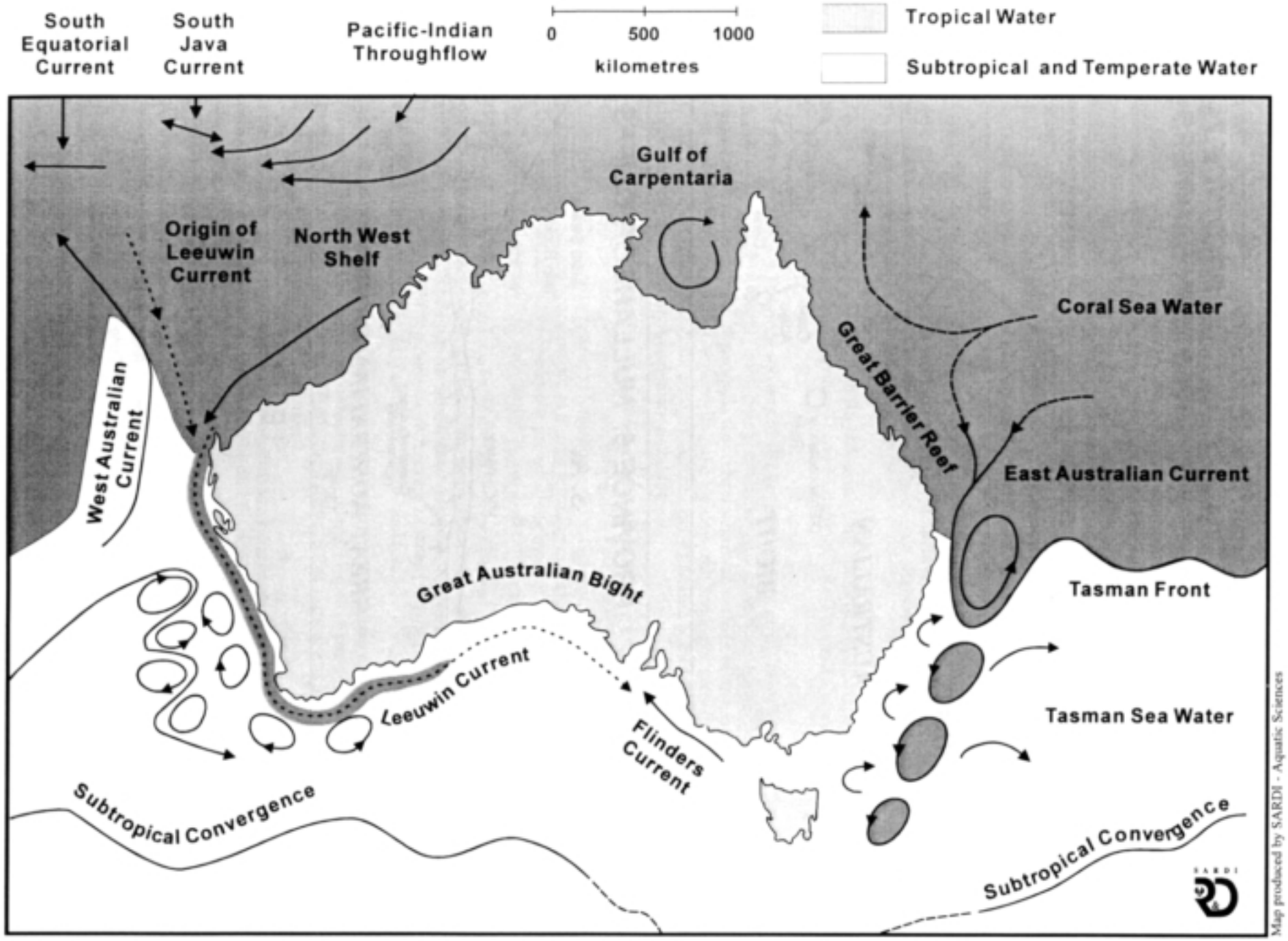
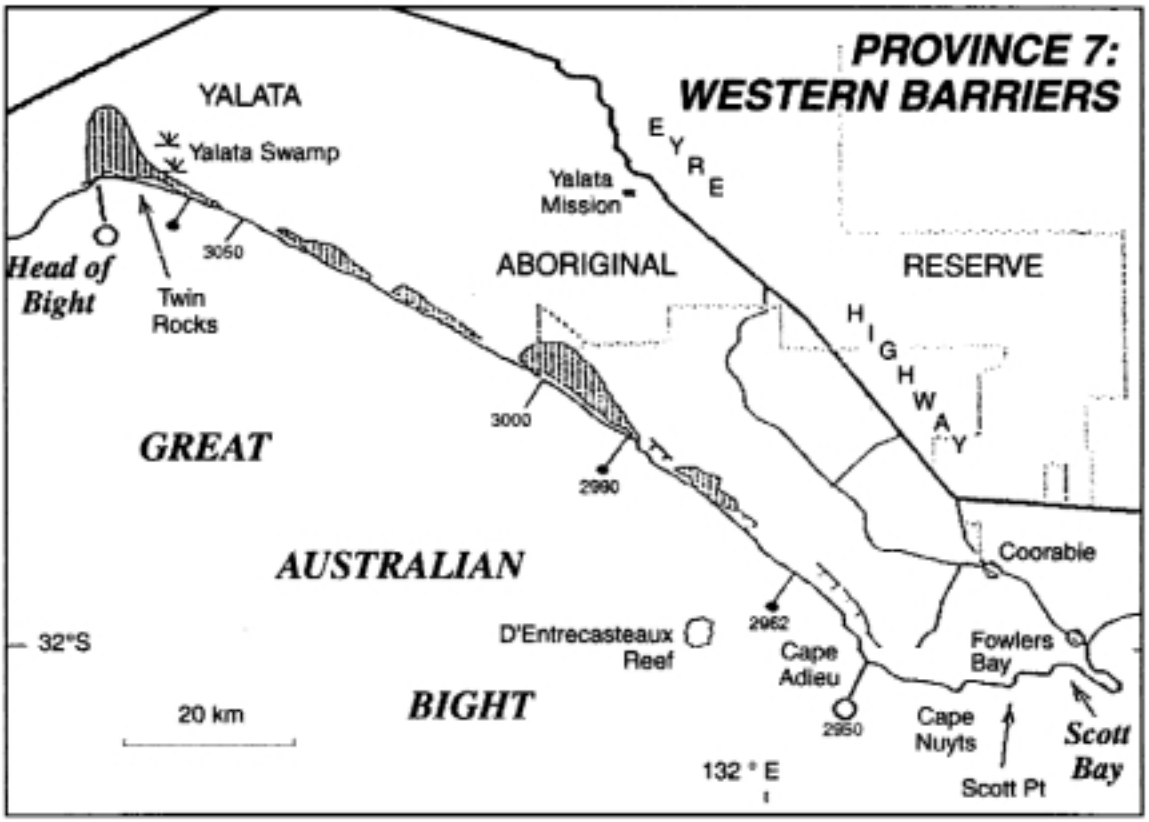
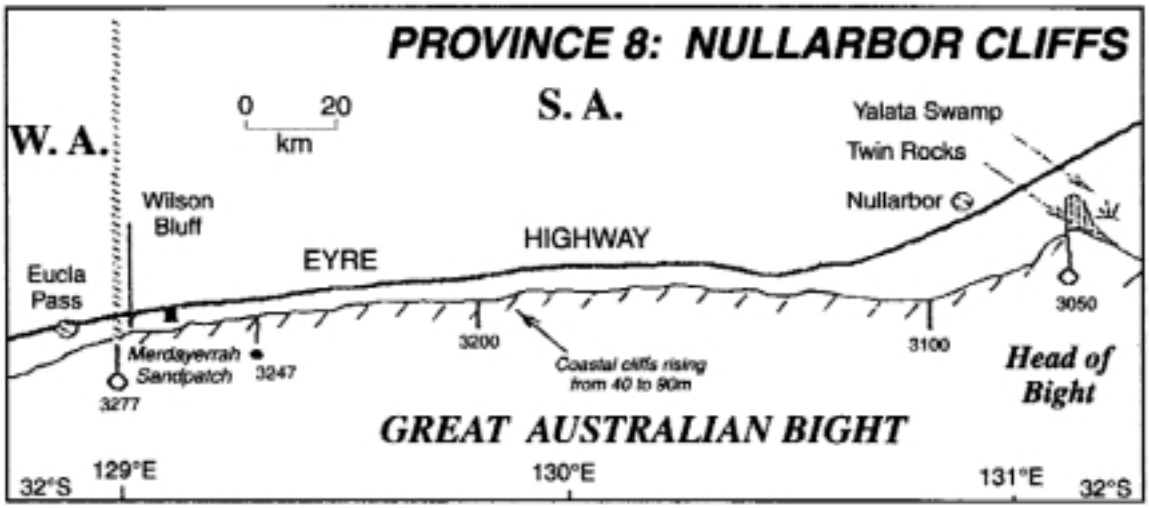


Figure 3: Major oceanographic features of the Great Australian Bight region (from Jeffrey *et al.* 1990).





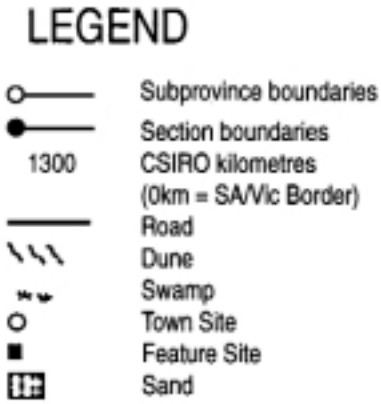


Figure 4: Coastal geomorphological provinces of the Great Australian Bight region (from Short *et al.* 1986)

Coastal Geomorphology (from Fotheringham 1994)

The major open coastal landforms of the Great Australian Bight can be divided into rocky and sandy sections. The rocky sections consist of Tertiary limestone cliffs (with the largest section comprising the Nullarbor Cliffs), Precambrian bedrock (usually capped by dune calcarenite) and Pleistocene dune calcarenite which is exposed in cliffs up to 150 metres high, usually fronted by well-developed shore platforms and reefs (Parker *et al.* 1985, Short *et al*. 1986, Curry 1987). The sandy sections include numerous beaches with backing foredunes and transgressive dunes. Finer sediments composing some bay shores and usually vegetated with mangroves and lagoonal deposits, occur in the eastern Great Australian Bight, outside the boundaries of the Marine Park. The sandy and rocky section are often found together, with beaches fronting stranded dune calcarenite cliffs, reefs commonly occurring off beaches, and many of the dune calcarenite cliffs capped by Holocene clifftop dunes.

Many offshore islands and reefs are occur in the Great Australian Bight, including the Recherche Archipelago (WA) and Nuyts Archipelago (SA) and the Investigator Group of Islands (SA) which includes the granite inselbergs of the Pearson Islands. No offshore islands occur within the Marine Park area.

The area within the Great Australian Bight Marine Park comprises two coastal geomorphological provinces: Western Barriers (Province 7) and Nullarbor Cliffs (Province 8) (see Short *et al.* 1986) (see Figure 4).

The Western Barriers Province consists of 122 km of southwest facing coast stretching from Cape Adieu to the Head of Bight, comprising extensive Holocene dune barriers interspersed with Pleistocene calcarenite. Further west, the Tertiary limestone cliffs of the Nullarbor Plain and Holocene and Pleistocene marine deposits at the Merdayerrah Sandpatch form the 209 km Nullarbor Cliffs Province. Due to the absence of surface pre-Quaternary bedrock both provinces are characterised by uniformity in orientation and form.

Along the Western Barriers Province Pleistocene calcarenite has strongly modified the distribution and form of Holocene sedimentation. Calcarenite cliffs have impeded inland sand drift. Calcarenite headlands have blocked or restricted longshore sand movement. Outlying calcarenite reefs have in places greatly reduced nearshore wave energy resulting in variable beach and dune environments. High energy nearshore wave conditions prevail along most of the province producing dissipative beaches backed by 4 to 7 km wide transgressive sand drifts and stable vegetated parabolic dunes.

Where reef protection occurs moderate energy intermediate and low energy reflective beach types occur. These have narrower beach faces and steeper beach gradients than dissipative beaches with significantly reduced potential for inland sand transport. In consequence the backing dunes are considerably smaller. Clifftop dunes with fronting beaches indicate that beaches have either been transgressed by rising sea levels or eroded due to sand loss.

At the Head of Bight the Yalata dunes form the most extensive active dune transgression. Historic records indicate that the dunes are transgressing inland 11 metres per year. Sediment analysis of beach and dune sands at the Head of Bight show they are fine to medium carbonate rich sands with silica content slightly higher in the dunes.

The high, continuous cliffs of the Nullarbor Cliffs Province have been little affected by the Holocene period apart from re-activation of Pleistocene cliff faces. Shore platforms are absent due to weakly consolidated lower cliff materials. Sediment produced from cliff erosion is too fine to produce beach sand.

At the Merdayerrah Sandpatch, Pleistocene calcarenite and Holocene marine sediments front the Nullarbor Cliffs to form a narrow coastal plain which stretches 30 km to the State border. Longshore transport of sand from the nearby Roe Plain is the most likely source of beach and dune materials. High silica content (40 - 70%) indicates that reworked pre-Quaternary bedrock may form an important component of the sediment. Due to calcarenite reefs, nearshore wave energy is low and beaches mainly reflective. The backing dunes are unvegetated and highly active. In several places cliff face sand ramps have formed and the Nullarbor Cliffs have been overtopped by dune sands. Pleistocene calcarenite dune ramps are also evident.

3 BIOLOGICAL VALUES

Considerably less is known about the biological components and processes of the marine ecosystems in the Great Australian Bight region in comparison with the adjacent terrestrial ecosystems. This is due largely to the generally inaccessible and inhospitable nature of the coastline and the fact that only relatively recently have there been technological innovations which have facilitated the study of marine environments. Nevertheless, research studies already undertaken indicate that the Great Australian Bight is a region both of high marine biodiversity and of globally significant populations of rare and endangered marine mammals. Although all whales, dolphins, porpoises and seals are protected in Australian waters of the Great Australian Bight by State and Commonwealth legislation (p. 25 Part A), there is a need to provide additional protection for the key calving and breeding habitats of these animals.

3.1 Biogeography of the Great Australian Bight

Along the southern coast of Australia, marine biogeographers recognise a major biogeographic region, known as the Flindersian Province, which extends from south-west Western Australia to southern New South Wales and includes the waters of Victoria and Tasmania (Figure 5). Within this broad region, the coastal waters of the Great Australian Bight are recognised as warm to cool temperate (in contrast to the cold temperate waters of the south-east of Australia, west of Robe).

Under the habitat classification scheme for Australian marine and estuarine areas proposed by the Australian Committee for the International Union for the Conservation of Nature, the proposed Great Australian Bight Marine Park embraces one biogeographical region, known as the South Oceanic Zone, which extends from Cape Pasley, near Esperance (WA), eastwards to Cape Catastrophe, near the entrance to Spencer Gulf (SA) (ACIUCN 1986) (Zone 17, Figure 7). At a finer scale, the near-shore regions encompassed by the Great Australian Bight Marine Park fall within a smaller scale biogeographical region, known as the Murat Bay Bioregion (MUR in Figure 6).

Many of the marine habitats and ecosystems of the southern temperate regions of Australia, particularly in remote regions, remain poorly documented. Despite this, the few benthic habitat studies which have been conducted in the isolated regions of the Great Australian Bight indicate a high level of marine biodiversity and endemicity, particularly among the invertebrate fauna (such as ascidians (sea squirts) and nudibranchs (sea slugs)). In addition to the occurrence of many species of marine mammals, the region is also characterised by a warm, tropical element in the marine fauna and flora, which is thought to be a result of the influence of the warm waters of the Leeuwin Current.

Marine biodiversity and endemism

The rich marine biodiversity and high levels of endemism of this region are in part due to the long east-west extent of the southern coastline and the long period of geological isolation. Within the Flindersian Province, approximately 1200 species of macroalgae, 17 species of seagrasses, 110 species of echinoderms and 189 species of ascidians have been recorded (Shepherd 1991). Of these, approximately 85% of fish species, 95% of molluscs and 90% of echinoderms are endemic (Poore 1995). Similarly, the marine macroalgal diversity in the region is among the highest in the world, with over 75% endemism in the red algae (Womersley 1990). In contrast, approximately 13%, 10% and 13% of fish, molluscs and echinoderms, respectively, are endemic in the tropical regions of Australia (Poore 1995).

The waters of the Great Australian Bight also contain some of the richest assemblages of ascidians in the world, with over 200 described species (Greenwood & Gum 1986). Many of these species have been recorded near the offshore islands of the Great Australian Bight region and among the extensive limestone cave systems of western Eyre Peninsula. Bryozoans and nudibranchs are also very well represented in the waters of the Great Australian Bight.

It is generally recognised that maintaining biodiversity will depend on the success of a variety of measures to protect and manage in an ecologically sustainable way habitats and species which exist outside formal conservation reserves. An essential part of any such strategy is a system of protected areas, which should be designed and managed to represent and protect the divserity of ecological communities, species and gene pools. (*Global Biodiversity Strategy* WRI/IUCN/UNEP 1992). (See Box 4).

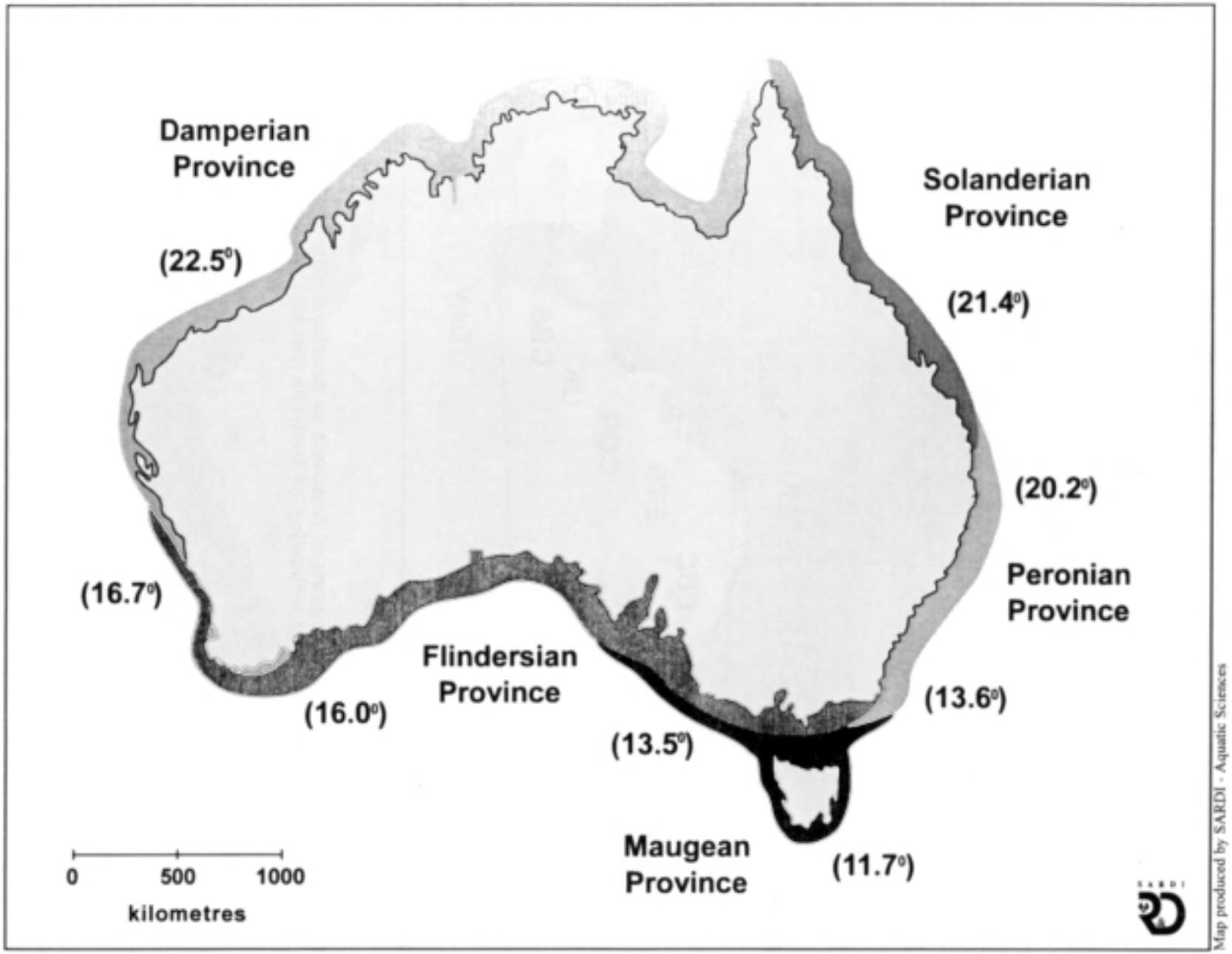


Figure 5: Major marine biogeographical provinces of Australia (from Womersley 1990)

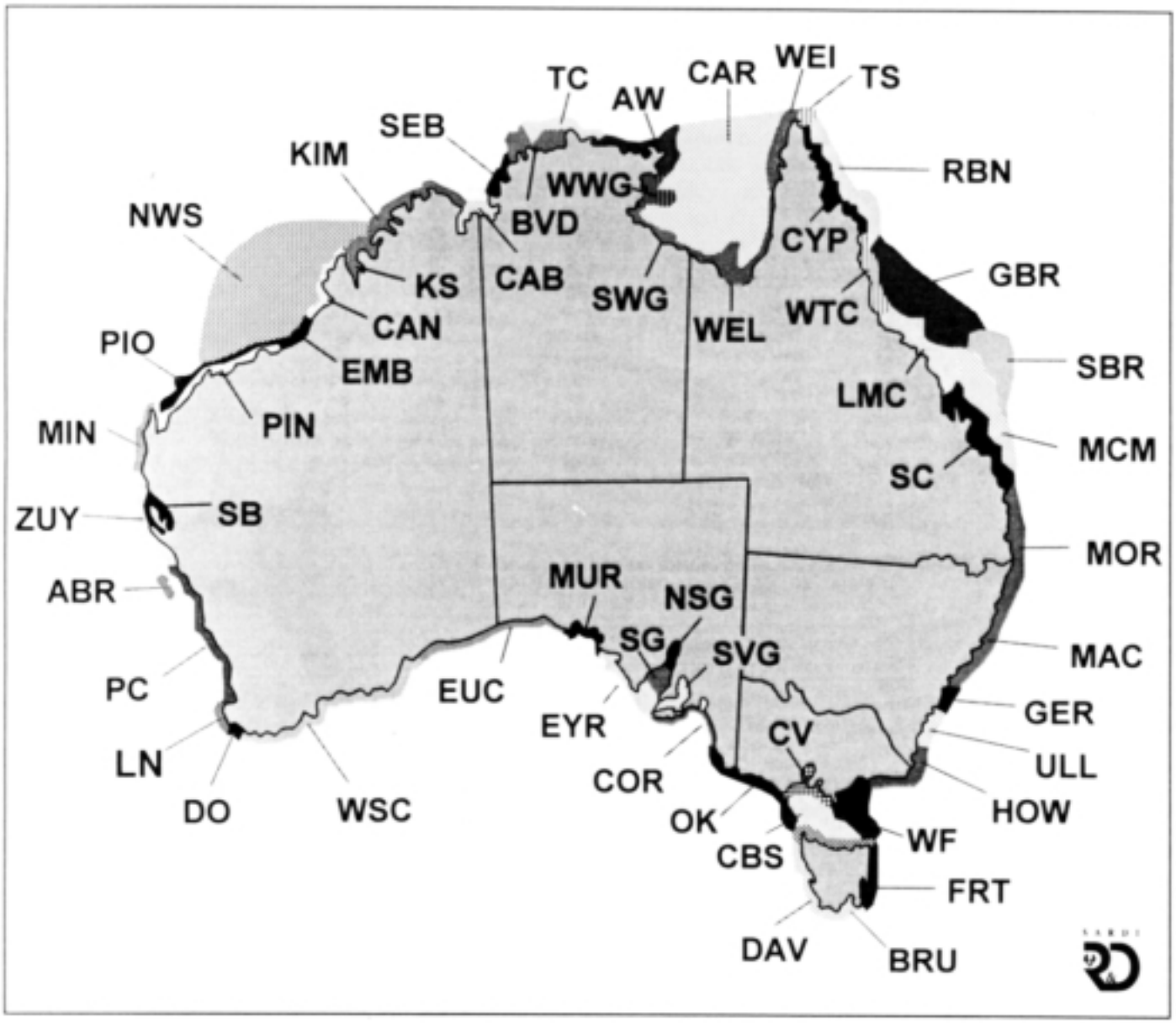


Figure 6: Marine and coastal bioregions of Australia as developed through the Interim Marine and Coastal Regionalisation of Australia (IMCRA 1996).

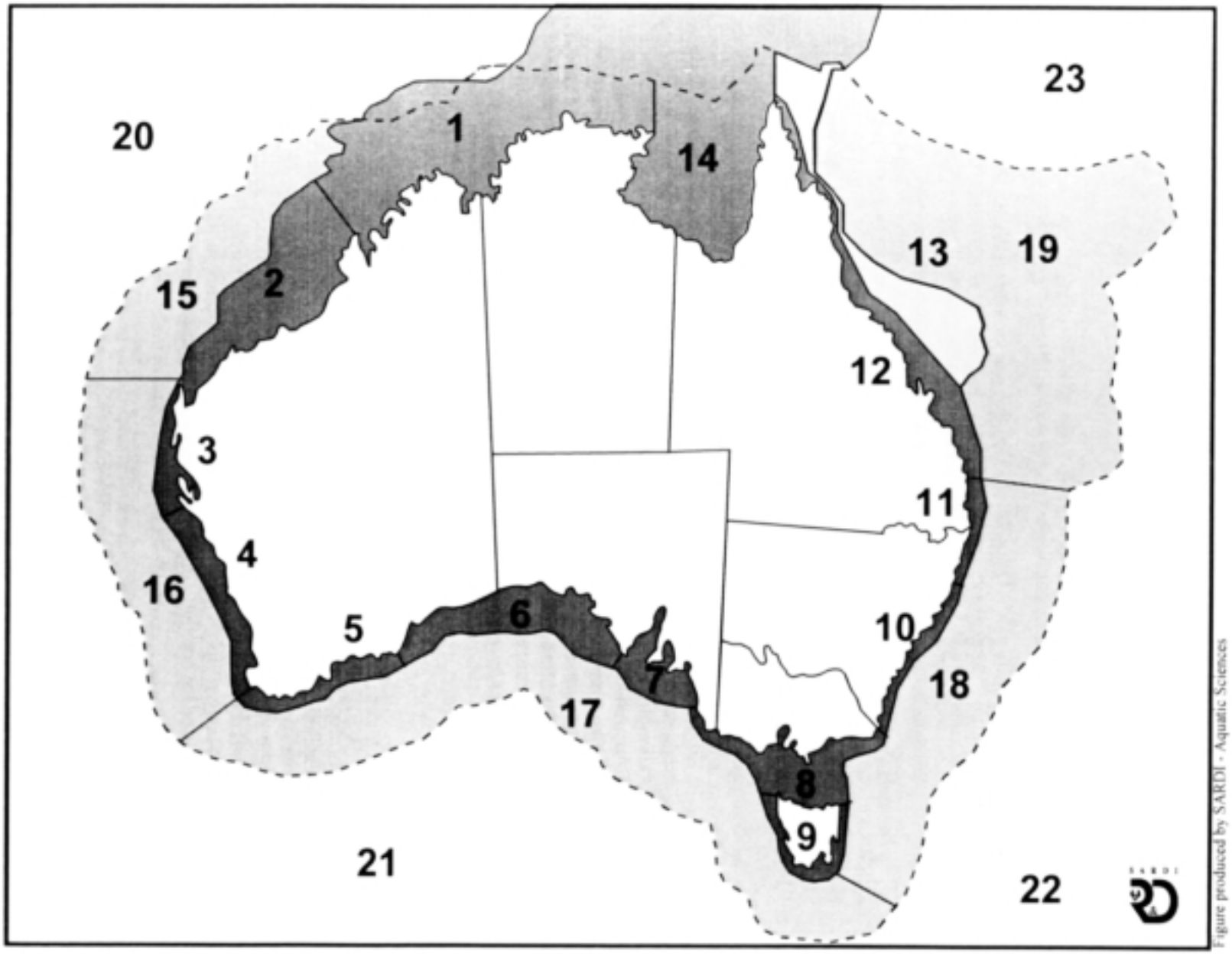


Figure 7: Marine and coastal biogeographical regions of Australia (endorsed by ACIUCN and CONCOM 1985).

Box 4 A Global Network of Marine Protected Areas

Article 6 of the *Convention on Biological Diversity* (UNEP 1992) states that signatory Nations shall:

(a) develop national strategies, plans or programs for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs which shall reflect, inter alia, the measures set out in this convention relevant to the contracting Party concerned; and

(b) integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plan, programs and policies.

At the global level, the International Union for the Conservation of Nature (IUCN), through its Commission on National Parks and Protected Areas (CNPPA), has been carrying out a programme to promote the establishment of a global representative system of marine protected areas (MPAs).

The primary goal of the IUCN-CNPPA Marine Protected Areas Programme is:

'to provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of Marine Protected Areas and through the management, in accordance with the principles of the World Conservation Strategy, of human activities that use or affect the marine environment.'

Influence of the Leeuwin Current

The Leeuwin Current is a critical ecological process determining patterns of marine biodiversity in the Great Australian Bight. As a major determinant of the eastern boundary current system off the west coast of Australia, this warm, low salinity current originates from the tropical Indian Ocean and during winter from May to September-October, flows south along the shelf break of the west coast, along the southern coast of Australia, to the eastern Great Australian Bight (to approximately 130^0E) (Rochford 1986). The warm, low salinity waters of the Leeuwin Current are responsible for the distribution, migration and patterns of dispersal for a wide range of pelagic and demersal fauna and flora within the Great Australian Bight. Warm waters in the nearshore regions of the Great Australian Bight, particularly at the Head of Bight, have recently been confirmed (Petrusevics 1991). However, the relative contribution of coastal heating from land, versus the easterly extent of the Leeuwin Current, is still a subject of conjecture.

Tropical flora and fauna

The warm waters of the Great Australian Bight are also characterised by a unique 'tropical' or Indo-Pacific element both in the demersal and pelagic fauna (Maxwell & Cresswell 1981). Among the benthic invertebrate fauna, many of the echinoderm species recorded from South Australia originate from the Indo-Pacific region (Maxwell & Cresswell 1981). For instance, some 20 of the 84 species of hydroid recorded from South Australia have their principal distribution in the warm waters of the Indo-Malay region. Other echinoderms of Indo-Pacific origin include the Basket Star (*Euryale aspera*), and the holothurians, *Pentacta anceps* and *Pentacta quadrangularis* (Maxwell & Cresswell 1981).

The warm Leeuwin Current is also responsible for the dispersal of pelagic marine organisms from waters north-west of Australia to the southern seaboard (Maxwell & Cresswell 1981). Tropical pelagic species, such as the Oriental Bonito and the Southern Bluefin Tuna move with the Leeuwin Current in their migration from the spawning grounds in the Java Sea. These same warm equatorial waters are also thought to be responsible for the significant tropical element in the phyto- and zooplankton of the Great Australian Bight (Markina 1976) and the suspected relic tropical assemblage in the marine flora (i.e. *Sargassum* spp.).

The influence of the Leeuwin Current is also reflected in the Holocene sediments of the Eucla Shelf, which are characterised by a lack of bryozoans, and an abundance of coralline algae and the large foraminifer, *Marginopora* (James *et al.* 1994).

For coastal and offshore fisheries, the Leeuwin Current is intimately linked to the population dynamics of many of Western Australia's and, to a lesser extent, South Australia's, commercially important species (Lenanton *et al.* 1991). The life history characteristics, such as spawning, migration, recruitment and feeding patterns, and ultimately the overall production, of many species along the western and southern seaboard of Australia have evolved under the influence of such a current system. Almost all of the major economically important fish stocks off the western and southern coasts of Western Australia are influenced to some extent by the Leeuwin Current (Lenanton *et al*. 1991).

Some pelagic species use the Leeuwin Current to disperse from the north-western waters of Australia to the southern seaboard of Australia. For instance, the Southern Bluefin Tuna (*Thunnus maccoyii*) spawns in the Java Sea and migrates southward along the western Australian coastline and eastward along the southern coast of Australia. It is an important commercial species and its distribution and abundance is influenced by the seasonality, strength and timing of the Leeuwin Current. Other commercial pelagic fish whose distribution and abundance is affected by the Leeuwin Current include, Mackerel (*Scomber australasicus*), Horse Mackerel (*Trachurus declivis*), Australian Salmon (*Arripis truttaceus*), and Australian Herring (*Arripis georgianus*). Southern Bluefin Tuna and the latter two species are particularly important fisheries in South Australian waters (Cappo 1987, Jones 1991).

Cetaceans

The Leeuwin Current also brings warm waters to the Great Australian Bight. Since cetaceans are generally born with little blubber, the large calving aggregation of the Southern Right Whale in the Head of Bight region may be a good example of the importance of water temperature (Kemper & Ling 1991). The warm Leeuwin Current has also been suggested as a mechanism for bringing occasional individuals of tropical species such as Bryde's Whale into South Australian waters (Kemper & Ling 1991). Although water temperature may be an important factor in the presence of whales in the region, the varied shoreline within the Great Australian Bight, with its embayments and protected waters (such as around Ceduna, Streaky Bay and Coffin Bay) may also be important, as shelter for whales in adverse weather conditions. Within the Head of Bight region itself, the shallow topography and rocky cliff line (with significant wave refraction), probably ensure a low risk of stranding, and also, some degree of protection from deeper water predators in the region, such as the Great White Shark (*Carcharodon carcharias*), which is known to predate on young calves (S. Burnell, *pers. comm.).*

3.2 Marine habitats and flora

The coastal nearshore marine habitats of the Great Australian Bight Marine Park comprise mostly sand out to at least 2 - 3 km, interspersed with small narrow patches of low profile limestone reef (Edyvane & Baker 1996) (see Figure 8). East of the Head of Bight (131° 30'E) to the Western Australian border (132° 00'E), the area is characterised mainly by sandy habitat (69%), interspersed with patches of limestone reef which comprise approximately 31% of the total habitat area (Edyvane & Baker 1996). Within this region, the major reef habitats appear to occur east of the Dog Fence (131° 40' E), with reef habitats comprising approximately 26% of the total habitat area, compared with 5% of the total area in the region west of the Dog Fence.

Within the Great Australian Bight Marine Park Whale Sanctuary (130° 45.5'E to 131° 30'E), sand appears to be the most prevalent habitat (see Figure 8). Within this region, reef habitats represent approximately 3.5-4% of the total area mapped in the eastern sector of the sanctuary (131° 17'E to 131° 30'E). In the western sector of the sanctuary, reef habitat consists of a narrow coastal strip 0-100m from the Nullarbor cliffs (130° 45' E to 130° 55' E), with the rest of the habitat comprising sand.

West of the Head of Bight (130° 30'E to 129° 00'E), reef habitat is mainly confined to within 0 -100 m of the coastal cliffs of the Nullarbor, the rest of the habitat, seaward of the coastal reef, comprising sand, out to 2 - 3km. However, narrow sections of limestone reef, i.e. irregular patch reefs, do occur further offshore in the western Nullarbor region, near the Merdayerrah Sandpatch (129° 30'E to 129° 00' E), but sand is by far the dominant habitat.

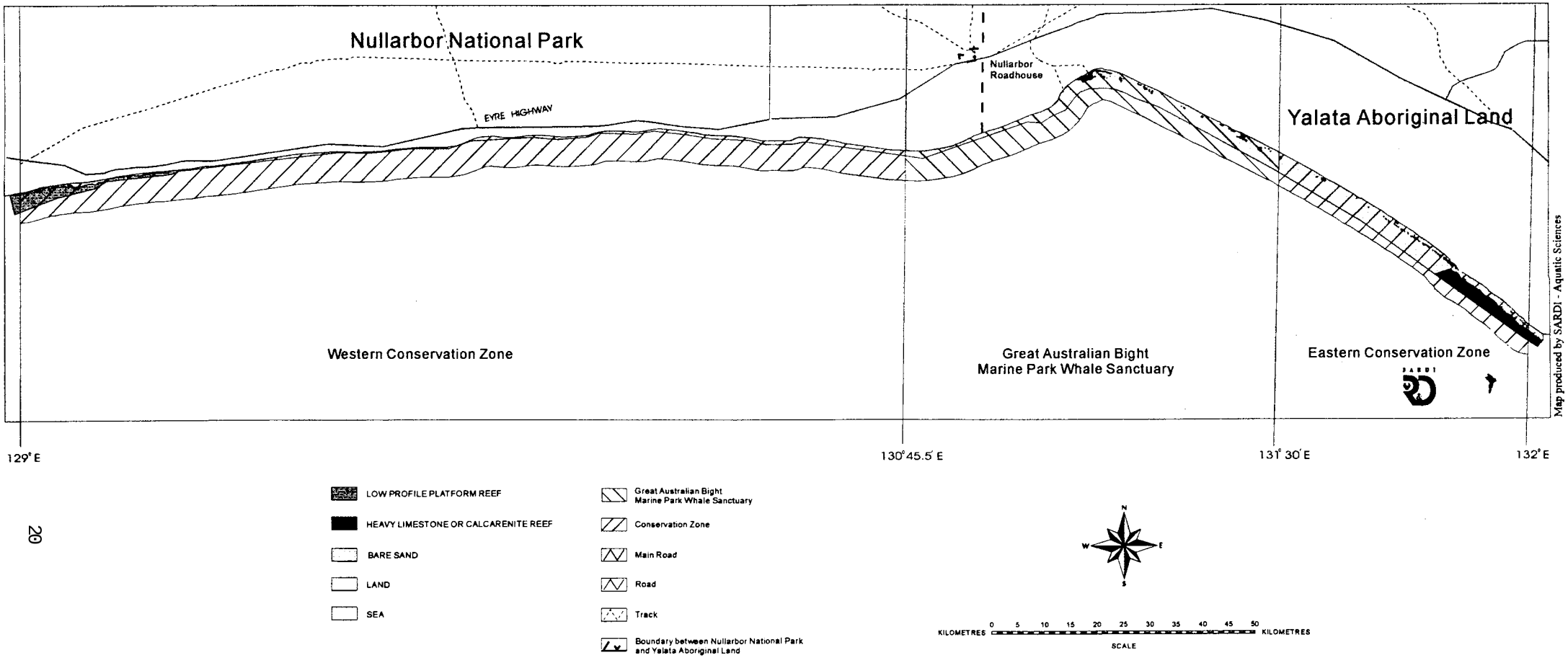


Figure 8: Major marine benthic habitats of the Great Australian Bight Marine Park.

Based on the area of reef habitat available for reef-associated species, existing and potential demersal fishing grounds for species, such as Blacklip Abalone and Southern Rock Lobster are likely to be limited within the Great Australian Bight Marine Park.

The marine benthic habitats of the Great Australian Bight have been the subject of few studies (see Figure 8). Surveys conducted by researchers from SARDI in June 1994 indicate benthic communities assemblages are typical of warm to cool temperate waters, and high swell wave conditions. On the rocky reefs within the Great Australian Bight Marine Park, subtidal macroalgal communities are dominated by the kelp, *Ecklonia radiata* and the fucoid *Scytothalia dorycarpa*. Of particular interest is the presence of a suspected relic tropical assemblage in the macroflora, indicated by the presence of an undescribed fucoid, *Sargassum* spp. No seagrass communities have been recorded within the boundaries of the Marine Park.

3.3 Marine Fauna

3.3.1 Southern Right Whales

Distribution

The Southern Right Whale (*Eubalaena australis*) is a baleen whale (i.e. a filter feeder) with a maximum length of 17 m and a maximum weight of 80 tonnes. Their distribution is circumpolar, between approximately 30^0 and 60^0 S, with summer feeding grounds located within sub-Antarctic waters. Southern Right Whales seasonally migrate to Australian coastal waters in the winter months between May and October to calve and mate, mainly on a three year cycle. Observation, lack of suitable prey (i.e. pelagic larval crustaceans and copepods) and whaling data suggest that no feeding occurs during the winter coastal season in Australian waters. This means that calving females fast for at least four months (Bannister *et al.* 1996). The summer feeding grounds and routes of migration to winter calving and breeding areas is not precisely known (Kemper *et al.* 1994), but probably comprises a broad front rather than a narrow migratory path (see Figure 9). Very recently, direct evidence of the presumed link between animals wintering on the southern Australian coast and those feeding in sub-Antarctic waters has been observed (Bannister *et al.* 1996).

Within Australian coastal waters, historical commercial whaling records for this species indicate that winter calving areas were once common in the protected bays and estuaries on the coasts of Tasmania, Victoria, South Australia, southern Western Australia and southern New South Wales, with occasional stragglers reported north of 25^oS. Currently, breeding and calving aggregations are restricted to western South Australia, and Western Australia along the shores of the Great Australian Bight to Cape Leeuwin, with peak abundances in areas such as the Head of the Great Australian Bight and Israelite Bay (see Figure 9). Along the western and central southern coast of Australia there appears to be some preference by calving females for shallow northeast trending bays over sandy bottoms, with animals occurring in a narrow band, generally no more than 1 km from the shoreline (Bannister *et al.* 1996).

The breeding and calving aggregation or nursery area at the Head of Bight is the largest in Australia and one of two major breeding areas in the world. Over half the calves born in Australian waters are born in this area. Low numbers of individual Southern Right Whales are also reported irregularly in areas off the New South Wales and Victorian coasts, with sporadic appearances of several individuals in favoured areas such as Warrnambool (Victoria), northwest and east Tasmania and eastern South Australia.

The Southern Right Whale is treated as distinct from the northern hemisphere North Atlantic Right Whale (*Eubalaena glacialis*). Other populations of the Southern Right Whale are considered to exist off South America, South Africa and New Zealand, with a possibility of other sub-populations occurring at southern oceanic and sub Antarctic islands. Some interchange is thought to be possible between South American, mid-Atlantic and South African populations. Australian populations of Southern Right Whales may not be homogeneous, with one group in the southeast and another moving in the southwest. Australian waters include the winter breeding grounds for possibly two of around seven Southern Right Whale populations.

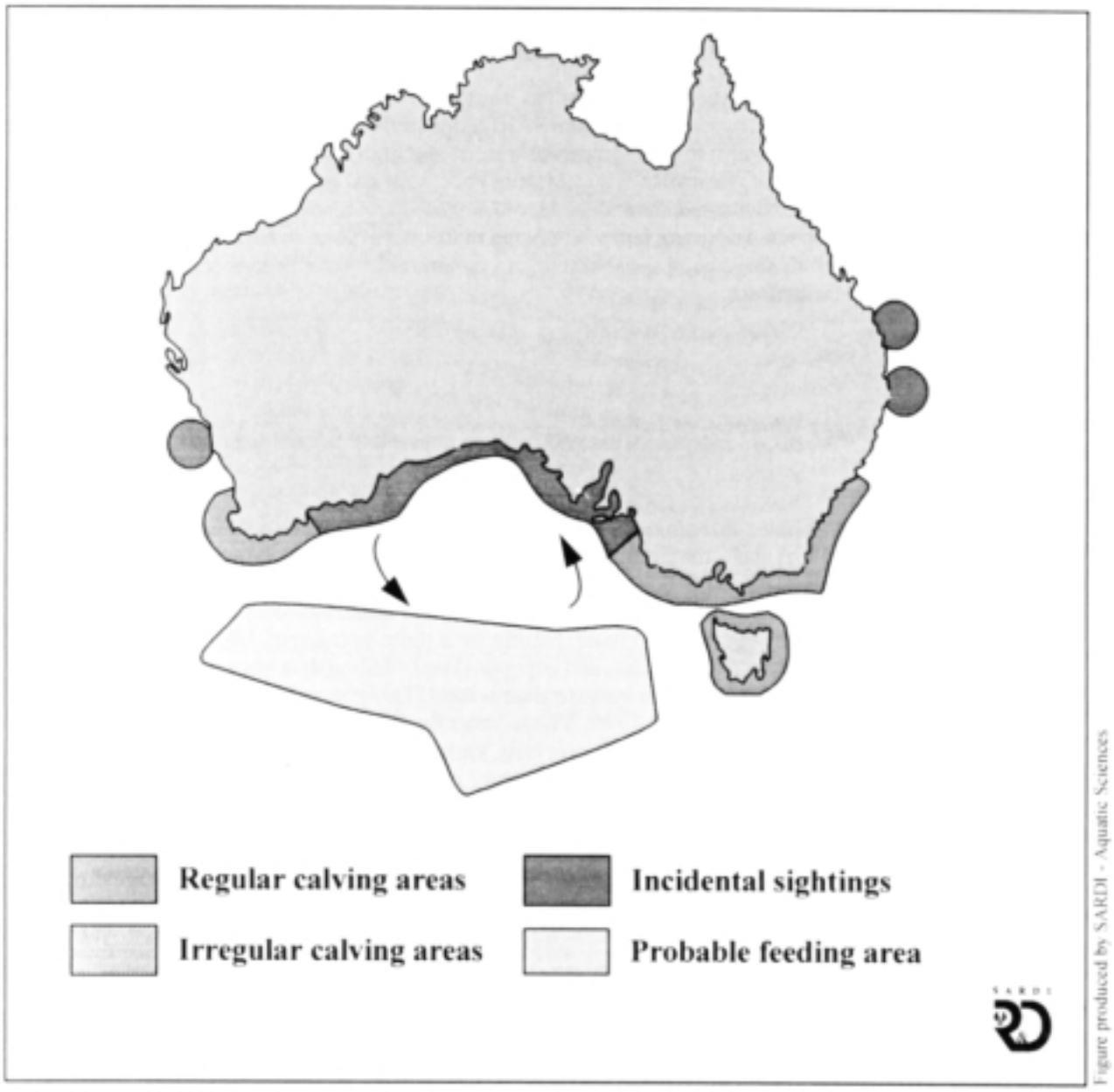


Figure 9: The breeding and feeding areas and migratory routes of the Southern Right Whale in Australian and New Zealand waters (from Marsh *et al.* 1995).

Conservation status of Southern Right Whales

Southern Right Whales are presently considered both 'endangered' (under the *Commonwealth Endangered Species Act 1992*) and 'vulnerable to extinction' (by the World Conservation Union—IUCN). Estimates currently put the world population of Southern Right Whales at around 1500 to 3000 individuals, with an Australian population of approximately 600 (Bannister 1993b). The populations off South Australia have shown no apparent increase (Ling & Needham 1991). While the species is presently recovering, the suspected very low diversity of the gene pool in the population (after being hunted to near extinction), has made the species particularly vulnerable to catastrophic collapses,which could result, for example, from environmental changes or the effects of human activities.

The Australian Nature Conservation Agency (now the Biodiversity Group of Environment Australia) under its Endangered Species Program, is developing a *Southern Right Whale Recovery Plan* (Box 6) and also a *National Cetacean Action Plan* (Box 5). Both strategies highlight the need for more coastal reserves which specifically protect cetacean resources from threats associated with the high and increasing levels of human activities in the inshore regions of Australia.

Box 5 National Cetacean Action Plan

The draft *National Cetacean Action Plan (*Bannister *et al. in press)* identifies a number of major threats to cetaceans (ie whales, dolphins) in Australian waters:

Immediate Threats

- direct killing
- entanglements in fishing gear
- shipping strikes, ie collision with vessels

Intermediate Threats

- competition from commercial fisheries
- oil spills
- disturbance and harassment (eg acoustic disturbance, whale watching from commercial and private vessels and aircraft
- degradation of cetacean habitat from physical modification (eg dredging, dredge fisheries) and biological modification (eg exotic introductions, pathogens)
- exposure to infectious human disease organisms
- episodic mass mortalities
- ignorance, accessibility and time scales

Long Term Threats

- contamination of marine environments by chemical pollutants
- contamination of marine environments by plastic debris
- reduced genetic variation
- resumption of commercial whaling
- global climate change

Box 6 Southern Right Whale Recovery Plan - Draft

A *Southern Right Whale Recovery Plan* has been drafted.With the extensive migration between summer feeding and winter breeding areas in more temperate waters, the successful conservation of the Southern Right Whale may depend on coordinated, or at least complementary action in areas under State, Commonwealth and international controls. The following is a list of management objectives recommended in the draft *Southern Right Whale Recovery Plan:*

14.1 Objectives

14.1 to ensure the recovery of the Australian population/s of the Southern Right Whale is as close to the maximum natural increase as possible

14.2 to ensure the recovery and maintenance of the populations at levels large enough to be resilient to chance events, including disease epidemics, episodic oceanographic change, inbreeding or anthropogenic environmental catastrophes

14.3 with the overall objective of returning the species as far as possible to unexploited abundances, age structure and productivity, ensure the recovery of the populations to at least 60% of the estimated unexploited population, as an estimator of pre-exploitation carrying capacity of the Southern Ocean and dependent ecosystems

14.4 to identify and characterise areas used historically and at present as preferred habitat for calving and breeding activity

14.5 to identify and to minimise impacts on whale populations using or expanding into such areas

14.6 to the extent possible, to identify and assess feeding areas, feeding behaviour and diet and interactions with other baleen whales

14.7 to develop baseline assessments of normal patterns of behaviour and movement, to provide a baseline against which to assess patterns in areas where whales are subject to potential stressors

14.8 to develop and implement proposals for marine protected areas to incorporate key calving and mating areas, migratory pathways and, if possible, feeding areas in international waters

14.9 to develop and implement measures to identify and minimise or eliminate potential impacts on recovery of Australian population/s in areas outside reserves, including fisheries, off-shore exploration and exploitation and commercial and recreational vessel traffic

14.10 develop and maintain a long-term education program for coastal areas and selected industries, including fisheries, shipping, defence forces and off-shore petroleum and mining industries, to foster awareness of the species requirements

14.11 continue and expland a long-term monitoring program, including a community-based component using local interest groups

14.12 further develop and maintain a National Catalogue of individually-identified Southern Right Whales for long-term use by all researchers

14.13 develop, implement and assess uniform legislative controls for recreational and commercial Southern Right Whale watching operations, for vessels, fixed wing aircraft and helicopters.

Value of the Great Australian Bight for Southern Right Whales

The region is a significant critical seasonal habitat for populations of Southern Right Whale. Within the Great Australian Bight region, specific areas such as the Head of the Great Australian Bight (Figure 10), represent one of the most significant habitats for the breeding and calving of Southern Right Whales in Australia, and one of two major calving sites in the world. Every year, between the months of May and November, approximately 50-60 whales visit the Head of Bight region to calve, nurse their young and breed.

In recent years, research at the Head of Bight has greatly enhanced our understanding of the reproductive biology and behaviour of Southern Right Whales (see Burnell & Bryden *in press).* Right whales generally begin arriving at the Head of Bight in mid-June, with numbers increasing and reaching a peak in July and August, before declining in early October (Figure 11). The duration of coastal residence for Southern Right Whales at the Head of Bight can potentially last up to 162 days, with whales recorded arriving as early as 10 May and leaving as late as 18 October in 1993, although on average the season extends for approximately 120 days (Burnell & Bryden *in press).* The effective calving season (ie. 95-100% of calves born) at the Head of Bight is shorter, lasting only 88 days in 1993 and 96 days in 1994.

Most births occur between mid June and mid August at the Head of Bight, with 100% of calves born before 31 August in 1993 and 23 September in 1994 (Burnell & Bryden *in press)* (Figure 12). The mean residence time of females that calved was 70 days, while unaccompanied adults remained resident for an average of only 20 days (Table 1). Individuals, usually unaccompanied adults, may visit more than one coastal location during their coastal residence (Burnell & Bryden *in press).*

Within the Head of Bight nursery area, female whales appear not to regularly use the deeper, western end of the site immediately before, and after, parturition (Burnell & Bryden *in press*). For birthing and during the period immediately post-partum, the majority of females remain in the shallow, sandy bay at the eastern end of the aggregation area. Late in the season, female-calf pairs have been observed following the shoreline to the west. It is thought that this may be a pre-emptory migratory behaviour, initiated by the female, to introduce the calf to the rigours of the southward migration before leaving coastal waters (Burnell & Bryden *in press*).

Over recent years this aggregation of Southern Right Whales at the Head of Bight has been the largest, densest and most consistent aggregation and nursery area in Australia, producing approximately one-third of the observed total number of right whale calves born in Australian coastal waters each year (Bannister & Burnell *unpubl. data,* cited in Burnell & Bryden *in press*). Recent studies at the Head of Bight have confirmed the size and density of the aggregation, with a total of 45 whales counted within the site on one day (in August 1994), and a total of 101 individual whales (based on photo-identifications) recorded during the winter of 1994.

The area at the Head of Bight also represents one of the few areas in the world where the breeding and general behaviour of the Southern Right Whales can be observed closely by the public. The proximity of the whales to shore and the unique cliff-top views afford some of best whale-watching

Table 1 Seasonal residence times of Southern Right Whales (*Eubalaena australis*) at the Head of the Great Australian Bight (from Burnell & Bryden, *in press*). The number of animals in each category (n) is shown in parentheses. (#denotes incomplete survey year).

Year	Start-finish dates & observation period (days)	Mean days within aggregation area	
		Calving females	Unaccompanied whales
1991#	13 Aug - 12 Oct (60)	23.4 (21)	5.8 (5)
1992	25 Jun - 10 Oct (111)	71.6 (17)	18.4 (18)
1993	18 Jun - 13 Oct (120)	74.8 (26)	20.2 (41)
1994	19 Jun - 12 Oct (116)	66.3 (24)	21.0 (74)

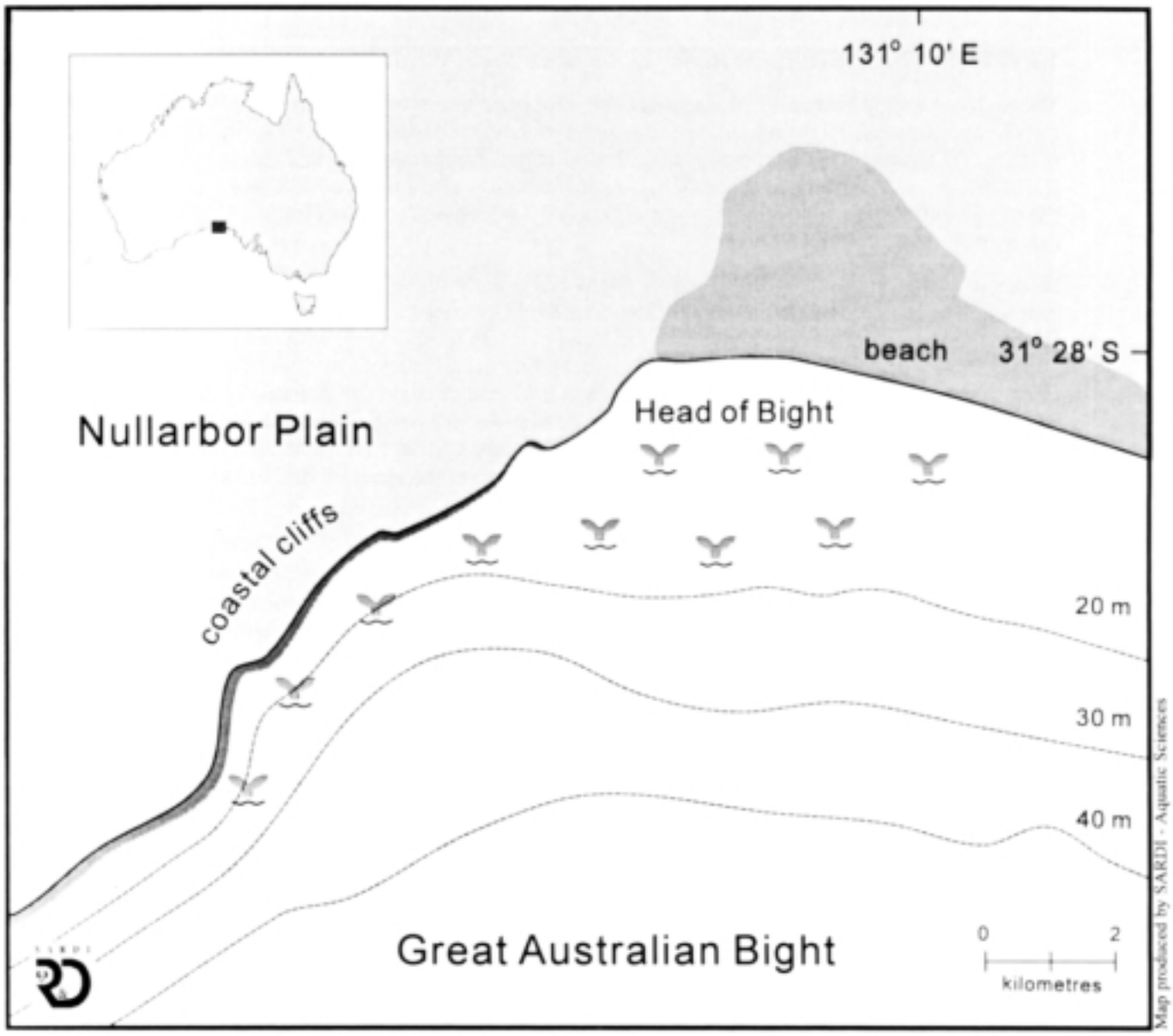


Figure 10: Head of Bight aggregation area on the southern Australian coast. Fluke icons indicate principal area used by Southern Right Whales (from Burnell & Bryden *in press*).

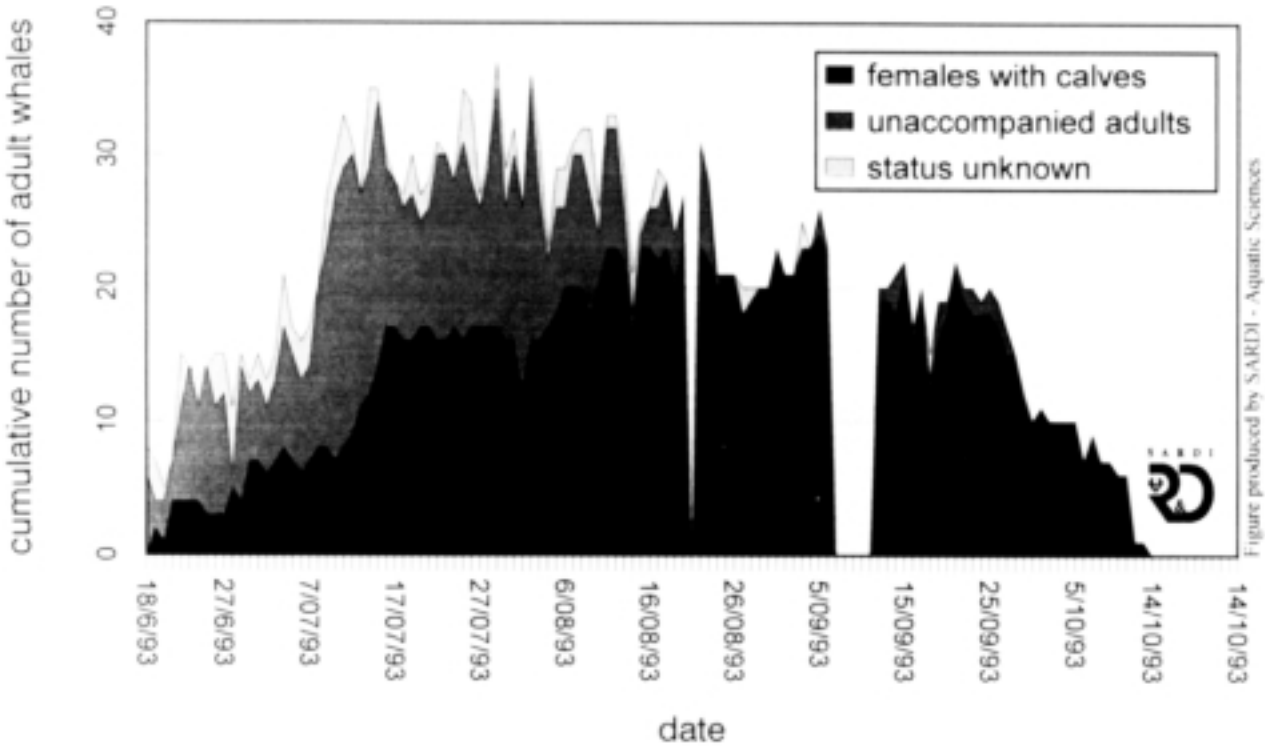


Figure 11: Daily census of adult whales at the Head of Bight aggregation area, 1993 (from Burnell & Bryden *in press*).

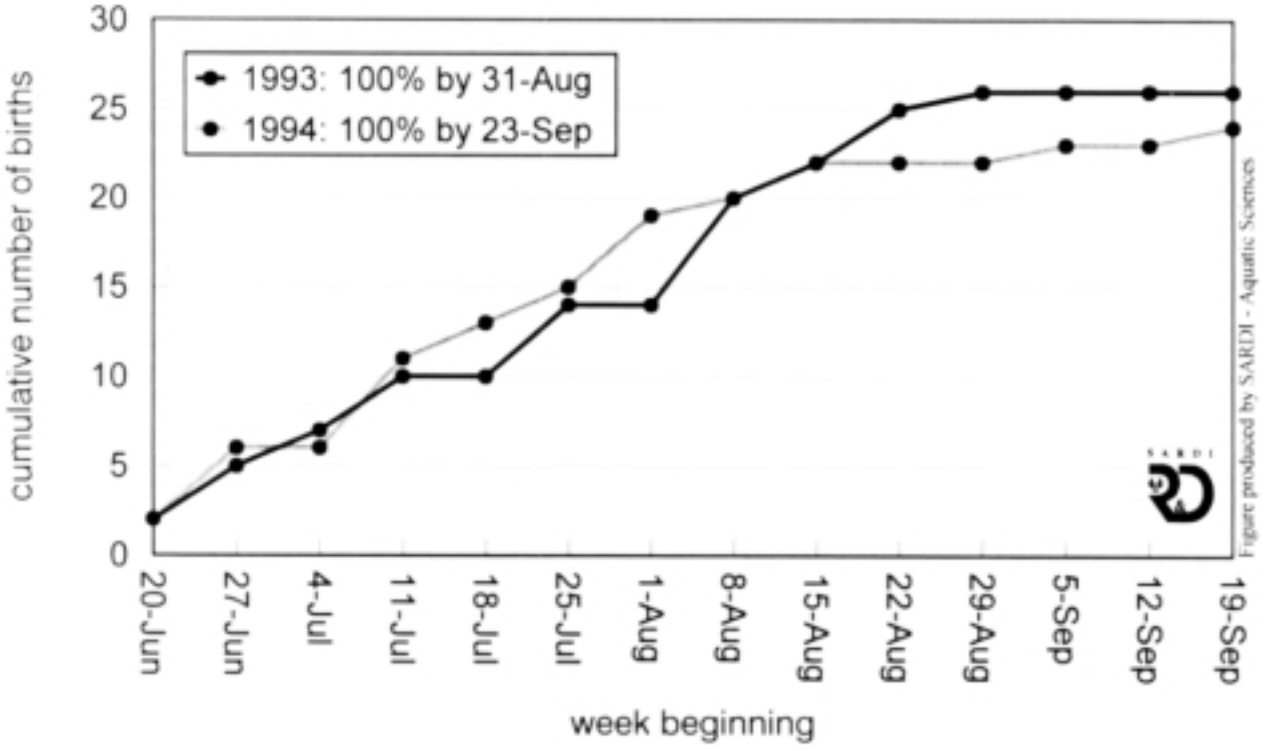


Figure 12: Cumulative births by week of Southern Right Whales at the Head of the Bight from June 20 in 1993 and 1994 (from Burnell & Bryden *in press*).

views in the world. For the same reason, the area also represents one of the best areas in the world where the breeding, calving and general behaviour of Southern Right Whales can be observed and studied by scientific researchers. Because of the absence of human interference in the area, these scientific studies are highly important in revealing the natural behaviour patterns of the whales.

The Great Australian Bight Marine Park not only protects the largest and densest breeding aggregation of Southern Right Whales in Australia, but also one of the two major breeding areas for this species in the world. While the Great Australian Bight region appears relatively unimpacted by human activities at present, protection of breeding and calving areas in the Marine Park is a major contribution to the world-wide recovery of this species (see draft *Southern Right Whale Recovery Plan 1995*, draft *National Cetacean Action Plan 1995*, Boxes 5 and 6).

Threats to recovery of Southern Right Whales

Southern Right Whales are protected in Commonwealth waters by the *Commonwealth Whale Protection Act 1980* and in State waters by the *National Parks & Wildlife Act 1972* from direct disturbance or harm. However, this legislation does not protect marine mammals from indirect disturbance (e.g. aircraft noise, fisheries entanglements, seismic drilling, coastal industrial activity) or direct habitat disturbance (e.g. dredging, pollution).

The degree to which marine mammals and cetaceans are threatened by these human activities depends essentially on their vulnerability to these risks. Populations of species most at risk are those which:

- occupy a restricted geographical range throughout the year in areas utilised by humans, in ways that could significantly impact on them
- occupy a narrow ecological niche which is utilised by humans, in ways that could significantly impact on them
- seasonally occupy a restricted geographical range or habitat for a critical biological function, in areas heavily utilised by humans, in ways that could significantly impact on them
- are specialised feeders on a narrow range of organisms or organisms at high trophic levels within the food web.

Among the cetaceans which frequent Australian waters, Southern Right Whales and Humpback Whales are particularly at risk from human activities. This is due to the location of their breeding and calving areas in the inshore coastal waters of Australia, their annual migration routes along the east and west coast of Australia and also, the period of overwintering in Australian waters. These factors put both these species at risk from high and increasing levels of coastal human activities. The major threats to cetaceans in Australian waters has been recently prioritised and summarised in the draft National Cetacean Action Plan (see Box 5). They include:

Impacts on feeding areas including global warming and increased competition from other species for common food resources resulting from changes in food web structure with reduction in abundances of large baleen whales.

Impacts on calving and breeding areas and along migratory routes, may include inshore habitat degradation from human activities, fisheries and off-shore petroleum and mineral exploration and exploitation. In some areas close to settlement centres, interference from commercial and recreational whale watching may be a cause for concern in the longer term. There is increasing evidence of acoustic disturbance from vessel traffic (Baker & Herman 1989, Bryden 1989). Perceived interactions may become more critical as a management concern as whale populations increase.

Entanglement and incidental by-catch which captures and drowns cetaceans in fishing nets and on long-lines is a local, regional and international threat of increasing concern. Even widely dispersed pelagic whales and dolphins are at risk, as a result of the number and extraordinary lengths, measured in kilometres, of individual monofilament drift-nets set by hundreds of vessels year-round in international waters. The by-catch of cetaceans is poorly documented for this and other fisheries, but the potential harm is clearly indicated by the known high mortality of dolphins, estimated in tens of thousands annually, taken incidentally in purse-seine fisheries in eastern tropical Pacific.

Marine litter has the potential to cause mortality to mammals in the region. In recent years, results from annual beach litter surveys conducted at Anxious Bay (on the remote far west coast of South Australia) indicate that fishing activity has been a major contributor to to ocean litter in the Great Australian Bight (Figure 13, Table 2 and Wace 1995).

Commercial exploitation would impede or reverse the recovery of Southern Right Whales. Under domestic legislation it would not be permitted in the Australian Fishing Zone, but all segments of the population spend significant periods each year in international waters.

There are several factors as to why the recovery of this species should not be taken for granted, for example:

- suspected very low diversity of the gene pool in the population after being hunted to near extinction; low genetic diversity makes a species vulnerable to catastrophic collapses due to environmental or other changes;
- location of the breeding and calving areas in the inshore coastal regions of Australia, where increasing human activity has the potential to threaten and disturb populations;
- endangered species with small populations, such as the Southern Right Whale, are particularly vulnerable to extinction. While the Great Australian Bight region appears relatively unimpacted by human activities at present, habitat protection of critical breeding and calving areas remains one of the most effective pro-active conservation measures to ensure species recovery of endangered marine mammals.

Commercial Whaling

The world population of Southern Right Whales has in the past been severely reduced by commercial harvesting. Estimates of initial Southern Hemisphere populations range from around 40 000 to 100 000 individuals, based on commercial catch records. However, recent evidence indicates that the global population may have been as large as 200 000 individuals (S. Burnell, *pers. comm.*). The current world population of Southern Right Whales is estimated at between 1 500 - 3 000.

Some populations of Southern Right Whales may have been reduced to a few individuals. Populations of whales occurred in large numbers in their winter calving and mating areas - located in protected coastal inshore waters. Here they were relatively easy targets for early bay whaling, with up to 50 shore-based whaling stations in operation at one time along the Australian coast. In addition, French, British and American vessels were also harvesting Southern Right Whales in their summer feeding grounds and along migratory paths, and in some cases, calving areas. The earliest reports of Southern Right Whaling in Australia were catches in 1805 from shore-based whalers in the Derwent estuary (Tasmania). Numbers of harvested Southern Right Whales were significantly reduced by the mid 1800s after less than 20 years of commercial activity, peaking in 1839. An estimated 26 000 were taken in the period 1826 to 1899, with more than 15 000 taken in Australian waters.

The extremely rapid global decline of Southern Right Whales is entirely attributable to commercial whaling in the early 1800s on high vulnerable breeding aggregations in a restricted preferred habitat (i.e. inshore protected waters). Commercial whaling peaked in 1820-30 in Tasmania and along the southern coast of Australia. With the advent of pelagic factory vessels, there may have been some opportunistic whaling of Southern Right Whales in transit to antarctic feeding grounds. The species was protected under international agreement from 1935. However, illegal whaling by commercial factory vessels was still occurring between 1940-65 (documented for the Tristan da Cunha population†; no information for Indian Ocean islands or areas to south of Australia).*

† Editor's note: in Flint, J 1963, *Oryx* 9 pp.28-32.

*Taken from presentation by S. Burnell in the Proceedings of the Great Australian Bight Marine Park Workshop, Ceduna, 28 February - 1 March 1994.

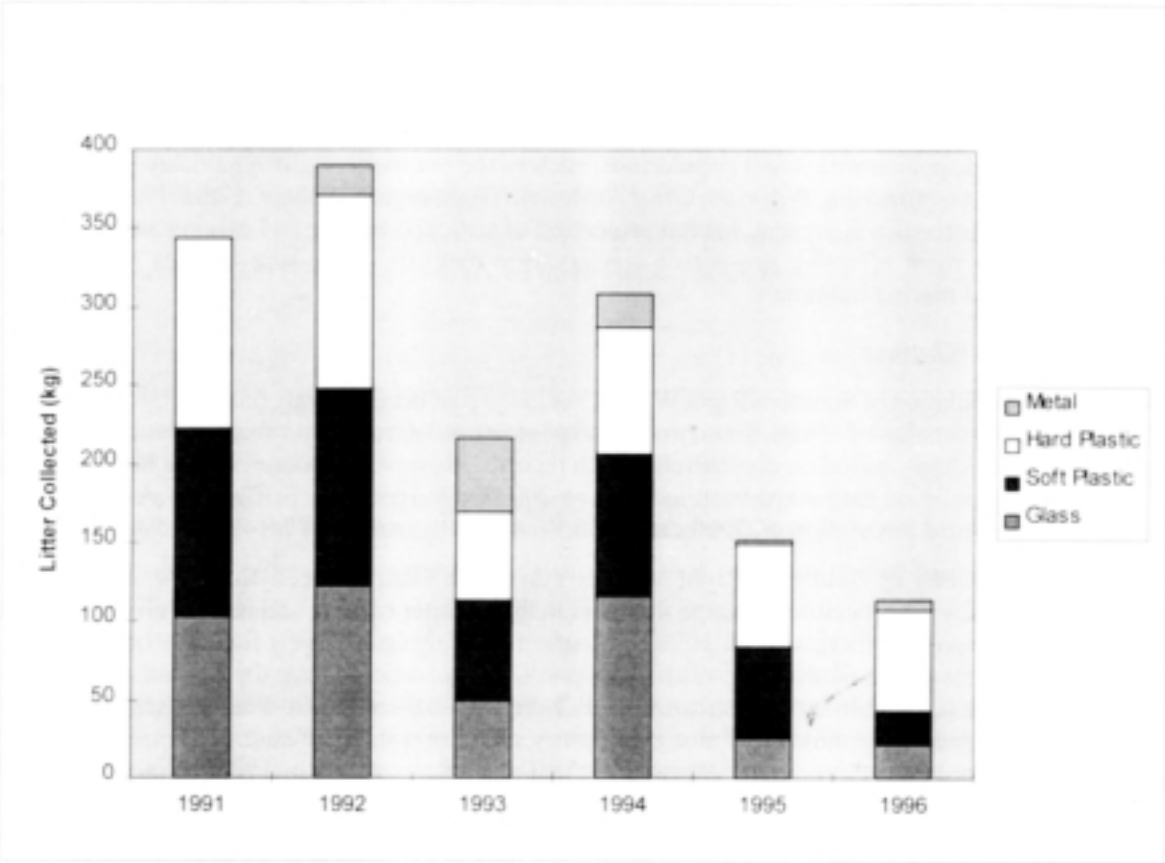


Figure 13: Marine litter in the Great Australian Bight, as recorded from the Anxious Bay ocean litter survey, 1991 - 1996 (SARDI *unpubl. data*).

Table 2 Major categories of marine litter in the Great Australian Bight, as recorded from the annual Anxious Bay ocean litter survey, 1991 - 1996 (SARDI, *unpubl.data)*.

TYPE OF LITTER	COMMON LITTER	1991	1992	1993	1994	1995	1996
Hard (moulded) Plastic		122kg	121kg	56kg	81.6kg	64.7kg	62.3kg
	liquid containers (bottles, tops, fragments)						
	drums, buckets						
	crates, boxes						
	bait/burley baskets						
	cray pot necks						
	buoys, floats						
Soft (flexible) Plastic/Rope		119kg	127kg	64kg	89.2kg	57.5kg	84kg
	bags and polythene sheeting						
	rope						
	nets						
	cod-ends						
	fishing line						
	bait straps						
	buoys and floats						
	six pack holders						
	polystyrene						
	rubber						
Glass		103kg	123kg	49kg	116kg	26kg	21.7kg
	bottles						
	jars						
	light globes						
	fluorescent tubes						
Metal (steel/aluminium)		n/a	20.5kg	47kg	21.5kg	2.5kg	6.8kg
	cans (food & drink)						
	drums (oil containers)						
	floats and buoys						
	aerosol cans						
TOTALS		344kg	391kg	216kg	308kg	150kg	174kg

International conservation of whales

The Indian Ocean Sanctuary was established by the International Whaling Commission (IWC) in 1979, and it presently provides an additional level of protection from commercial whaling in the Sanctuary area for the Western Australian segment of the population. Part of the Great Australian Bight Marine Park boundary occurs within the waters of the existing Indian Ocean Sanctuary.

In May 1994, the IWC established the Southern Ocean Whale Sanctuary (40°S) specifically to protect cetaceans and to assist the recovery of rare and endangered cetaceans. This Sanctuary specifically prohibits the commercial harvesting of cetaceans and affords a level of protection in the feeding areas of Australian populations of Southern Right Whales.

One of the aims of the Southern Ocean Whaling Sanctuary is to provide an area in which long term protection of major assemblages of cetacean species is ensured as an important reference area for present and future management. Australia and a number of other IWC countries will be cooperating in the development of an international research and monitoring program through the IWC, to improve the understanding of the recovery of species which the sanctuary protects.

The management and research activities undertaken within the Great Australian Bight Marine Park have the potential to make a significant contribution toward the sanctuary objectives, particularly for the conservation and management of Southern Right Whales.

Clearly from both, a national and international perspective, the Great Australian Bight Marine Park will be a significant contribution toward the conservation, management and recovery of Southern Right Whale populations.

3.3.2 Other Cetaceans

The Great Australian Bight region is a significant seasonal habitat for many other species of rare and endangered marine mammals. At least 17 species of cetaceans have been recorded including Sperm Whales and a number of Rorquals (Blue Whale, Minke Whale and Humpback) (Kemper & Ling 1991). In the draft *National Cetacean Action Plan* (ANCA, *unpubl.),* the Blue Whale (*Balaenoptera musculus musculus)* is listed as 'endangered', the Humpback Whale (*Megaptera novaeangliae)* is 'vulnerable', while the Sperm Whale is listed as 'insufficiently known' category and potentially vulnerable.

Blue, Sperm, Minke (*Balaenoptera acutorostrata)* and Humpback Whales are quite commonly sighted, and become stranded around the Bight. Possibly resident cetaceans are the Beaked Whale, Killer Whale (*Orcinus orca)* and Risso's Dolphin (*Grampus griseus*). Individuals of tropical species such as Bryde's Whale (*Balaenoptera edeni)* are occasionally seen in South Australian waters, and it has been suggested that they have travelled on the warm Leeuwin Current (Kemper & Ling 1991). Bottlenose Dolphins (*Tursiops truncatus*) have been seen on many occasions playing amongst Southern Right Whale groups (Ling & Needham 1988, Bannister 1993b).

3.3.3 Sea lions and seals

Distribution

Two species of seals or pinnipeds breed in the Great Australian Bight region—the rare Australian Sea Lion *(Neophoca cinerea)* and the New Zealand Fur Seal *(Arctocephalus forsteri)* (Edyvane & Andrews 1995); others are found there as vagrants. The region contains many breeding colonies of these species and is an area of conservation significance for these species. The Australian populations of the New Zealand Fur Seal are limited in their distribution to the Great Australian Bight, and are found on the islands of Recherche Archipelago (WA), eastwards to Kangaroo Island (SA) (Figure 14).

Australian Sea Lions are presently limited to the offshore islands of Western and South Australia, from the Houtman Abrolhos to the islands of Recherche Archipelago (WA), and from Nuyts Reef to Kangaroo Island (SA) (Figure 14). Major breeding areas in South Australia include the Pages, Dangerous Reef and Seal Bay, Kangaroo Island (Robinson & Dennis 1988, Gales 1990). In South Australia, Australian Sea Lions have been recorded on a total of 69 offshore islands and reefs and three mainland sites (Robinson & Dennis 1988). In South Australia, a total of 23 offshore islands,

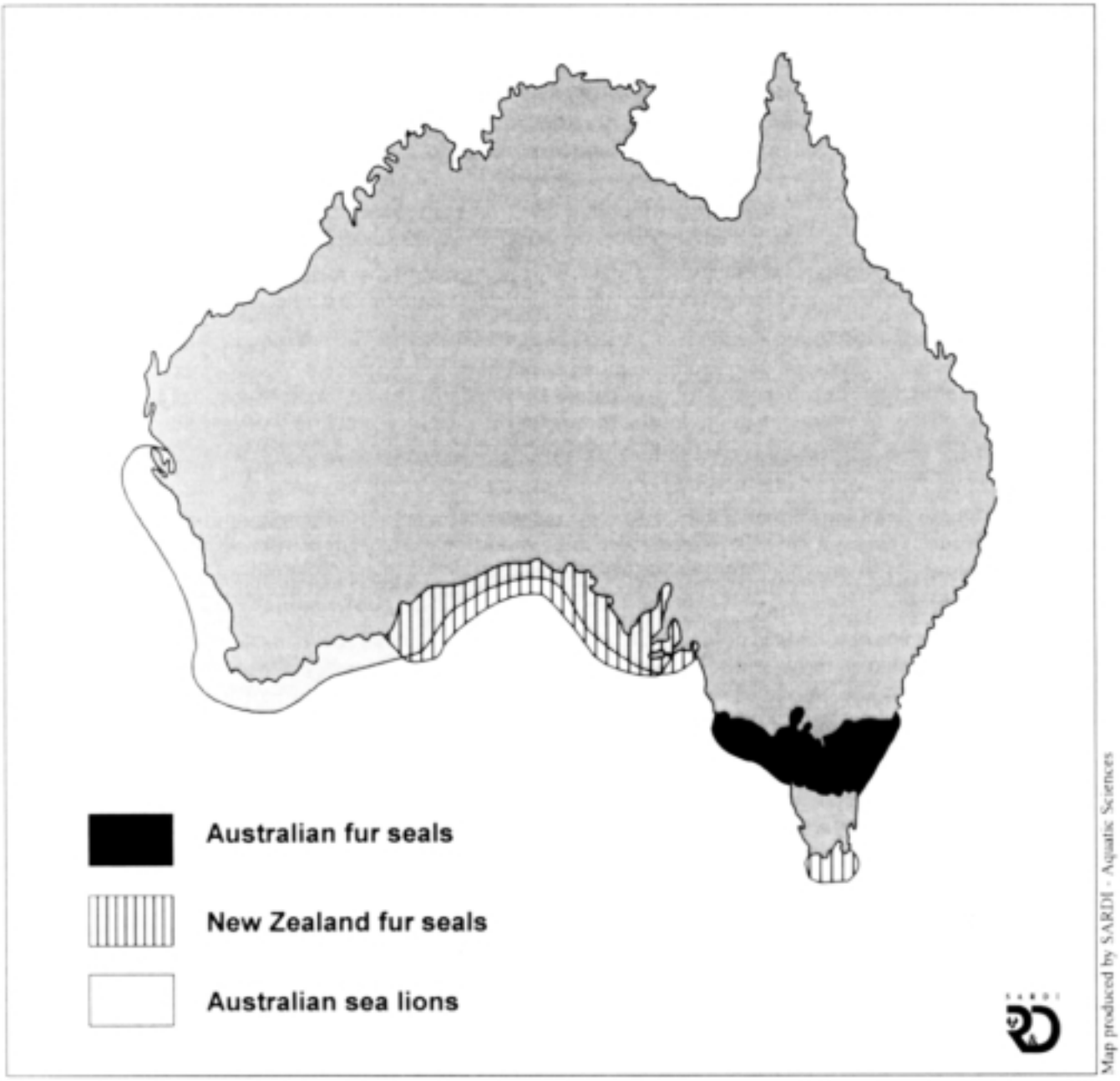


Figure 14: The breeding range of Sea Lions and Fur Seals in Australia (from Marsh *et al.* 1995).

particularly off the Eyre Peninsula, support breeding populations of sea lions, while in Western Australia, a total of 27 islands support breeding colonies. A further 19 islands may also support breeding colonies (Gales *et al*. 1994). Point Labatt on western Eyre Peninsula was, until recently, the only and largest recorded mainland breeding site for this species in the world. The recent discovery of numerous small breeding colonies of Australian Sea Lions along the Nullarbor Cliffs (within the boundaries of the Great Australian Bight Marine Park) (Edyvane & Andrews 1995, Dennis & Shaughnessy 1996) however, have now made the Great Australian Bight the major location for mainland breeding colonies of this species (Figure 15, Table 3).

Numbers of sea lions at the Point Labatt Aquatic Reserve colony have varied from 14 to 82 between 1966 and 1983. A more recent survey conducted in 1990 recorded 42 sea lions and 4 pups (Gales 1990).

Australian Sea Lions are unique among pinnipeds in having an aseasonal 17 - 18 month breeding cycle, which has been reported for populations on Kangaroo Island, South Australia and on the west coast of Western Australia. Furthermore there is a lack of synchrony of breeding seasons between these sites. No fixed breeding season has been demonstrated for any of the other South Australian colonies (Gales *et al.* 1994).

Australian Sea Lions are relatively sedentary and do not undertake definite migrations (Marlow 1991, Shaughnessy 1994). They feed at sea, mostly on fish and cephalopods in relatively shallow nearshore waters, making short trips of 20 to 30 km and feeding in depths of 60 - 80 m (Costa *et al.* 1988, 1990).

Although most of the world population of the New Zealand Fur Seal occurs in New Zealand, there are a few colonies in Australia. Breeding colonies occur on the islands off the southern coast of Western Australia, on islands at the entrance to Spencer Gulf (South Australia), and on Kangaroo Island (Shaughnessy 1990). There are 13 breeding colonies in South Australia where counts of pup numbers have given rise to an estimated total population for South Australia of 27 500 (Shaughnessy *et al.* 1994). In the Great Australian Bight the most westerly South Australian colonies are located on Nuyts Reef and the most easterly sites in Western Australia are on the Recherche Archipelago; between these two a number of haul-out sites have been recorded (see Table 4).

Conservation Status of Australian Sea Lions

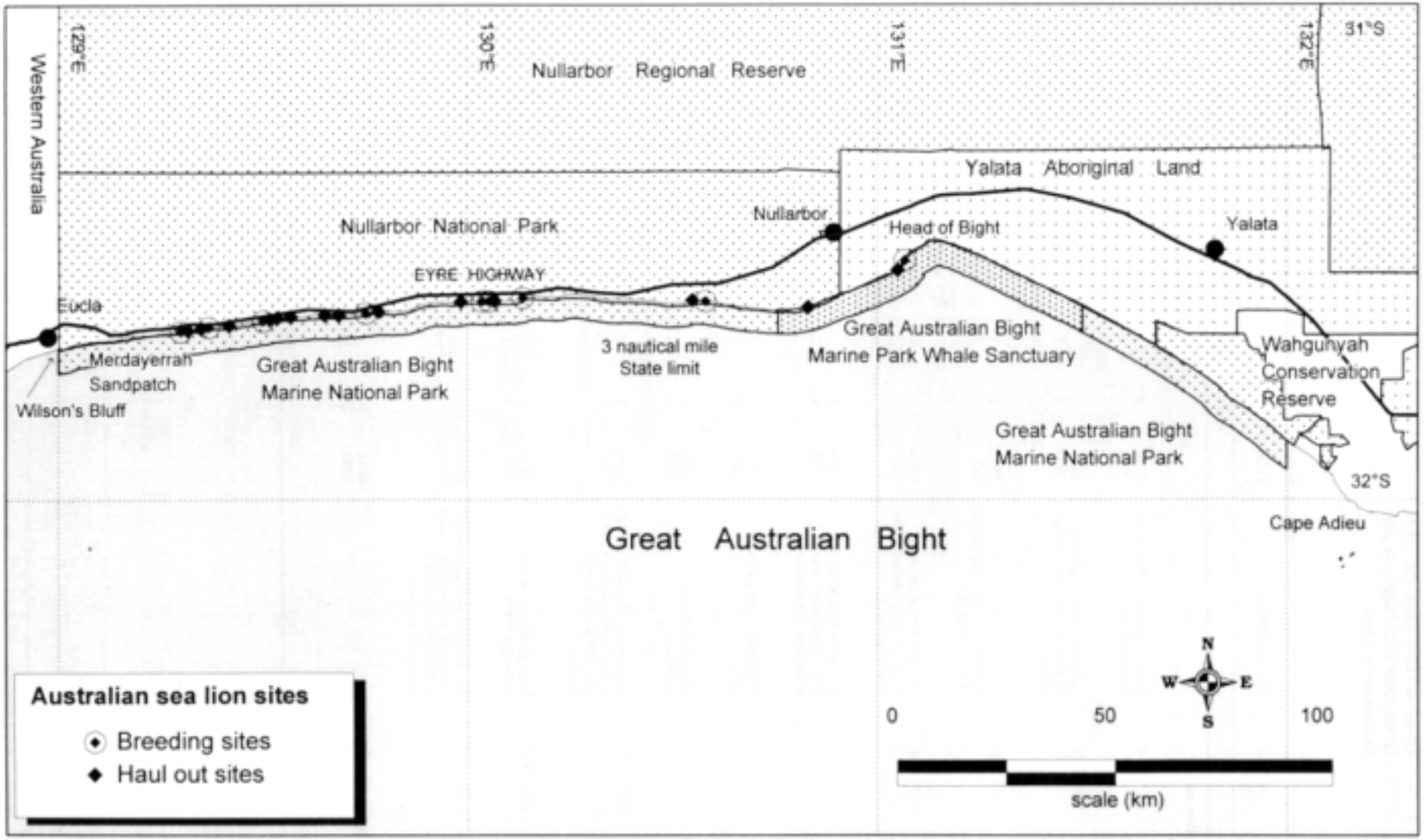
The Australian Sea Lion is one of Australia's most endangered marine mammals and it is endemic to Australia (Gales 1990). The species is recognised as 'rare' under South Australian legislation; a 'Special Protected Species' in Western Australia; and 'rare' by the IUCN. Prior to seal-hunting, this species occurred along the whole of the southern coastline, but is now confined to the waters of South Australia and Western Australia. The estimated world population for this species is 10 000 - 12 000 individuals, with estimated population sizes of 7 500 sea lions in South Australia and 3 100 in Western Australia (Gales 1990, Gales *et al*. 1994). This makes makes long-term management and conservation of this species a particular responsibility and obligation for South Australia.

The New Zealand Fur Seal does not presently fall into any of the IUCN 'threatened' categories (i.e. critically endangered, endangered or vulnerable), but is currently recognised as 'conservation dependent' in the lower risk IUCN category (Dennis & Shaughnessy 1996).

Value of the Great Australian Bight for sea lions and seals

Recent systematic surveys of potential seal haul-out sites along the coastline of the Great Australian Bight, from Twin Rocks to Wilsons Bluff (ie. a coastal distance of approximately 206 km) have identified approximately 280 Australian Sea Lions and 12 New Zealand Fur Seals (Dennis & Shaughnessy 1996). In 1994, a total of 289 Australian sea lions were recorded at 23 sites widely dispersed at the base of the Bunda Cliffs, while in 1995, a total of 284 sea lions were recorded at 10 sites. (Dennis & Shaughnessy *in* 1996). Of these sites, 9 occurred in South Australia, and 1 occurred in Western Australia (2 km west of Twilight Cove). Overall, a total of 10 breeding sites and 14 haul out sites were identified for the region.

Australian Sea Lions were found hauled-out on perched platforms formed by collapsed sections of the cliff at various levels above the sea. In 1994, a large colony of 37 sea lions were recorded in a deep cave accessed from the sea. In 1994 a total of 86 pups (under 12 months) were recorded, while in 1995, 90 pups (under 6 months of age), were recorded, of which 44 were still in lanugo



Map produced by the Reserve Planning Section, Natural Resources Group, DENR
Map projection is AGD66 in decimal degrees

Figure 15: Australian sea lion sites in the Great Australian Bight (after Dennis & Shaughnessy, 1996)

Table 3 **Location of breeding and haul out sites of the Australian Sea Lion *(Neophoca cinerea)* in the Great Australian Bight, recorded between August 1994 and August 1995 (from Dennis and Shaughnessy 1996*)***

Site no	Longitude (°E)	Site description	Year	Age - Sex Category* - see footnote p.37						
				Bull	Sam	Cow	Juv	Uc	Pup	M.Pup
Breeding sites										
B1	131° 04.4'	Cave, entrance 3-4m above inter-tidal zone	1994	4	2	9	7	4	2	9
			1995		1	21	7		8	5
B2	130° 35.0	Cobbled ramp; platforms; worn pathways; pup shelter; caves	1994			1		4‡		2
			1995	5	1	2	2		2+	
B3	130° 08.6'	Low platforms; worn pathways; caves; pup shelter (110 km lookout)	19941	1	1	2	1	4‡	1	2
			995	1	2	11	1	6	9	4
B4	130° 03.8'	Platform 90x40 m; worn pathways; pup shelter; 400m east of pinnacle	1994			1	2			1
			1995`			2	2		1	
B5	130° 02.7'	Platforms 100x50 m; two sites 150 m apart; worn pathways; pup shelter	1994	2		5	1		1	2
			1995	4	2	9	3		13	5
B6	129° 45.8'	Platforms; worn pathway; cave	1994		1	1				2
			1995	2		3	3		2	3
B7	129° 30.3'	High platform; worn pathways	1994	1		8	3		1	2
			1995			4	7			
B8	129° 22.7'	High terraced platforms 180 x 50 m; worn pathways; two sites 300 m apart; pup shelter	1994	3	1	4	4	2‡	1+	4
			1995	7	4	13	10		6	10
B9	129° 18.4'	High platforms; worn pathways; cave	1994	3	2	9	9	3‡		7
			1995	1	1	6	5	3	1	6
B10	126° 00.7'	Small beach behind rockfall; cave; pup shelter (2 km west of Twilight Cove) (not surveyed in 1994)	1994							
			1995					5	2	
Totals for breeding sites			**1994**	**14**	**7**	**40**	**27**	**17**	**6**	**31**
			1995	**23**	**11**	**71**	**40**	**14**	**44**	**33**

continued opposite

Table 3 **Continued. Location of breeding and haul out sites of the Australian Sea Lion *(Neophoca cinerea)* in the Great Australian Bight, recorded between August 1994 and August 1995 (from Dennis and Shaughnessy 1996*)***

Site no	Longitude (°E)	Site description	Year	Age - Sex Category* Bull	Sam	Cow	Juv	Uc	Pup	M.Pup
Haul-out sites										
H1	131° 03.5'	Low platform 100 x 30 m; worn areas (not surveyed in 1995)	1994 1995			1	2	4‡		1
H2	130° 50.2'	Platform; cave; cobbled ramp (vacant in 1995)	1994 1995		1	1				1
H3	130° 33.6'	Low platforms; worn pathways; cave	1994 1995			 1	1	3‡		1
H4	130° 04.0'	High platform; worn pathways; pup shelter (vacant in 1995)	1994 1995				2‡			1
H5	129° 59.7'	Terraced platforms; worn pathways; two sites 400 m apart (not surveyed in 1995)	1994 1995			4	2	4‡		6
H6	129° 47.0'	Platform 120 x 40 m; worn pathways; cobbled ramp; pup shelter	1994 1995		1		2‡ 2	1‡ 2		1 1
H7	129° 41.9'	Platforms; cave; pup shelter	1994 1995			3 1	 2	3‡		4
H8	129° 39.9'	Platforms; worn pathways; cave; pup shelter	1994 1995	 1		2 1		4‡		3
H9	129° 34.8'	Platforms; worn pathways (vacant in 1995)	1994 1995					7		
H10	129° 32.6'	Platforms 75 x 50 m; worn pathways (vacant in 1995)	1994 1995			5		2‡		3
H11	129° 31.2'	Cliff undercut at base (animals in sea 1994, none sighted 1995)	1994 1995		1‡	1‡	2‡			9‡
H12	129° 25.8'	Low platforms 180 x 50 m; worn pathways; pup shelter (40 km lookout)	1994 1995	1 2	 2	3 2	2 4	2‡		8 2
H13	129° 21.3'	Platforms; worn pathways; cave; pup shelter	1994 1995		 1	3 2	2 4	4‡		3 2
H14	129° 19.6'	Platforms; worn pathways; cave	1994 1995	2		12 6	6 5	2‡ 1		8 8
Totals for haul-out sites			**1994** **1995**	**3** **3**	**3** **3**	**35** **13**	**21** **13**	**36** **3**		**49** **13**

* Age and sex categories are: bull, sub-adult male, cow, juvenile, unclassed, pup and moulted pup.
• Pup shelters consist of vegetation or broken rock with cavities.
‡ These animals recorded in the sea nearby.
\+ One dead pup in lanugo at each of B2 and B8.

Table 4 Location of haul out sites of the New Zealand Fur Seal *(Arctocephalus forsteri)* in the Great Australian Bight, recorded in August 1994 (from Dennis and Shaughnessy 1996)

Longitude (°E)	Site description or comment	Age-sex category*		
		Sam	Juv	Uc
131° 02.5'	Hauled-out on broken rock	1	1	1
130° 48.6'	Hauled-out; hassled by SAM sea lion		3	
130° 43.9'	70 m offshore with three sea lions			1
129° 41.5'	100 m offshore			1
129° 25.8'	Hauled-out adjacent to sea lion colony			1
129° 18.4'	Hauled-out adjacent to sea lion colony		3	
Totals		**1**	**7**	**4**

* Age-sex categories follow those used by Goldsworthy and Shaughnessy (1994) - see footnote p.37

(Dennis & Shaughnessy 1996). Breeding events were recorded at one colony over three seasons and were consistent with an eighteen month breeding cycle. At one colony the number of pups recorded from the cliff-edge in August 1994 was doubled when a subsequent count was made by entering the colony.

By extrapolating from the number of sea lion pups found in the 1994 survey, the population of the Great Australian Bight region in South Australia has been estimated at between 613 and 744, which represents approximately 9.3% of the South Australian population or 6.6% of the total world population for this species (Dennis & Shaughnessy 1996). The significance of the populations of Australian Sea Lions in the Great Australian Bight is further increased because it is very likely that the populations were never commercially harvested. This is principally because of the isolation and general inaccessibility of the Great Australian Bight coast, both, from land and sea. Thus the populations have remained intact, providing a very important genetic and geographic bridging population between the South Australian and Western Australian sea lion populations (Dennis & Shaughnessy, 1996). Many other populations along the southern coasts and islands of Australia last century were exploited, very often to the point of extinction.

Threats to recovery of Australian Sea Lions

Threats to the recovery of Australian Sea Lion populations in Australia are similar to those which affect whales (see p. 28) and include human disturbance to breeding colonies and haul out sites, fisheries entanglements, competition with fisheries for common prey species and the effects of oil spills (Marsh *et al*. 1995). Breeding populations of both *Neophoca cinerea* and *Arctocephalus forsteri* are highly susceptible to disturbance by humans (Gales 1990, Shaughnessy 1990). Making breeding colonies prohibited areas has been recommended as the most straightforward method of protecting these colonies (Gales 1990, Shaughnessy 1990).

The majority of Australian Sea Lion breeding locations recently recorded in the Great Australian Bight region are afforded some legislative protection within the Nullarbor National Park. However, none of the waters surrounding these breeding colonies are presently protected. Further, two sites, one at the base of the cliffs and the other in a cave (found by SARDI biologists in June 1994), are located on the Yalata Aboriginal Land Lease near Twin Rocks.

There are also sea lion breeding colonies at highway viewing points along the Eyre Highway (located 40 km and 125 km from the Western Australia border). Each is several hundred metres long, and situated directly below the car park areas. These colonies, based on the quantity of rubbish in them, have been subjected to disturbance from above. This includes car and truck tyres, highway signs and bottles, with each item having the potential to cause direct injury to the animals or, at the very least, some disturbance.

It is not currently possible to assess the level of direct competition between Australian Sea Lions and fishers. Sea lions are known to rob baits from lobster pots, as well as nets set for School Shark.

Interaction between sea lions and fishers can be expected to increase (Shaughnessy 1990). One outcome is incidental mortality of sea lions during fishing activity. In South Australia, sea lion entanglements in monofilament netting of 150 mm mesh (used in the shark fishery) is a particular problem (Robinson & Dennis 1988). Entanglement rates vary from 0.2% in a survey of Western Australia and South Australia populations (Gales 1990) to 0.3% at Seal Bay and The Pages (DENR). At The Pages, pups aged 4 - 20 months formed the group most affected. While the present rate of entanglements for Australian Sea Lions appears low, the effect on a rare species can be significant. For instance, studies on the closely related Hooker's Sea Lion in New Zealand, indicate that increases in mortality of only 1% is sufficient to cause the population to decrease (Woodley & Lavigne 1993).

Although the feeding areas of Australian Sea Lions are not known, they are known to spend a considerable proportion of their time either resting or traversing waters in the immediate vicinity of colonies. Therefore some of the adverse effects of the interaction between fishers and sea lions can be alleviated by the declaration of protected areas in the waters surrounding sea lion colonies.

There may also be an economic advantage to fishers in avoiding interactions with Australian Sea Lions. In the case of interactions between the longline fishery for Southern Bluefin Tuna and Albatrosses (which take bait from hooks), Brothers (1991) estimated costs to the industry at $7.2 million annually from decreased catch and $4.9 million in lost bait.

3.3.4 Seabirds

Very little information on seabirds has been collected in the Great Australian Bight, particularly feeding and nesting aggregations. While breeding colonies of Little Penguins (*Eudyptula minor)* are known to occur at the base of the Nullarbor Cliffs in the region, many seabird species, such as Short-tailed Shearwater (*Puffinus tenuirostris)* and White-faced Storm Petrel (*Pelangodroma marina),* probably feed in the area and/or breed wholly or largely on the offshore islands (eg Nuyts Archipelago and Franklin Islands) of the Great Australian Bight (Copley 1995). Other species which may frequent the Great Australian Bight include the Black-faced Shag, Eastern Reef Egret, Cape Barren Goose, White-bellied Sea-eagle, Sooty Oystercatcher, Pacific Gull, Fairy Tern, Crested Tern, Rock Parrot, and the Fleshy-footed Shearwater (Smith Island) (Eckert *et al.* 1985).

The Australian Raven breeds on myall-bluebush plains and on islands off the western Eyre Peninsula coast. Some of the offshore islands in the region are home to colonies of rare or nearly extinct birds. For instance, the Southern Stonecurlew which is found on Thistle and Boston Island, is largely extinct as a breeding bird on the South Australian mainland. There are also large breeding grounds for the Cape Barren Goose off the west and south coasts of Eyre Peninsula (Robinson *et al.* 1982).

Non-breeding migratory seabirds such as Albatrosses, Petrels and Prions are known to frequent the coastal and shelf regions of the Great Australian Bight, but to an unknown degree (Copley 1995). Other species breed on more protected, inshore islands along the coast. Goat Island in Coffin Bay, is of particular significance in being one of the most accessible South Australian breeding grounds of the Rock Parrot. The ABC islets in Venus Bay also carry breeding populations of this species and together with Jones Island and Little Eyre Island are of further significance for their breeding colonies of the Australian Pelican. Another local breeding bird of sheltered islands is the Eastern Reef Egret (Eckert *et al*. 1985).

The Little Penguin (*Eudyptula minor*) is the world's smallest penguin species (approximately 35 cm tall and 1.2 kg). The Little Penguin is only found in Australia and New Zealand. In Australia they breed between Fremantle in Western Australia, right across the southern coastline, including Tasmania up to about Sydney (Seager 1991). Little Penguins favour rocky shorelines which provide suitable breeding sites and are known to occur within the area bounded by the Great Australian Bight Marine Park (Reilly 1974). Specific threats to Little Penguins include fisheries entanglement in nets and predation from feral animals such as foxes and cats.

Potential threats to seabirds in the Great Australian Bight region include entanglements (longline, squid fisheries), competition for prey species (particularly pilchards), marine litter entanglements (see Figure 13) and human disturbance to nesting sites. Risks associated with longline and squid fisheries could be minimised by the introduction of night fishing practices, bird lines, weighted hooks and thawed bait, and bait-throwing devices for long line fisheries (Flaherty *in press*).

While competition between seabirds and commercial fisheries (for prey species) in the Great Australian Bight is presently undocumented, competition could potentially arise due to increased fishing effort (Flaherty *in press).* For instance, pilchards are an important food item for a number of seabird species. Extensive pilchard fisheries occur in bays to the west of the Great Australian Bight (Esperance, Albany, WA), whilst in SA, operations target areas east of the Bight. Other fisheries which may affect seabird populations include calamari and cuttlefish, which represent important prey for some albatrosses and other seabirds (Flaherty *in press*).

Nesting seabird populations in the Great Australian Bight region may also be affected by increased human visitation and use of coastal areas. For instance, foot, vehicle and vessel traffic disturbance could result in decreases in populations and local extinction of populations of White-bellied Sea Eagles, which nest along the cliffs in the region (Dennis & Lashmar 1996).

3.3.5 Fish Fauna

The fish fauna of the Great Australian Bight (particularly non-commercial species) is poorly known and there is an urgent need for detailed fish studies, for both inshore and offshore areas. However, the relatively few fish studies which have been conducted in the region indicate, that the marine fish fauna of the Great Australian Bight is typical of the Flindersian Province of southern Australian coastal waters (Glover & Olsen 1985). As such, many of the species recorded in South Australian waters, have also been recorded in southern and south-western Western Australian waters, and to a lesser extent, in the waters of western Victoria and north-west Tasmania. For instance, Hutchins and Thompson (1983) reported that of the 344 species they listed for south-western Western Australia, 61% extended eastwards to, at least, off South Australia. There are some 300 species of known marine fish recorded off the Great Australian Bight down to the base of the continental slope, which represents approximately 67% of the species recorded from all South Australian marine waters (Glover 1982).

Most of the species in the Great Australian Bight tend to be inshore with fairly permanent resident populations. Of particular note, is the abundance of the White Shark (*Carcharodon carcharias*) in the Great Australian Bight and western Eyre Peninsula region, which may be due to the abundance of prey species, such as pinnipeds (Bruce 1992). However, there are also some regular migratory visitors such as the Australian Salmon and occasional oceanic vagrants such as oceanic Sunfish (*Mola* sp.), Basking Shark (*Cetorhinus maximus*), Black Marlin (*Makaira indica*), and the Lizardfish (*Saurida undosquamis*). Their presence in these waters can be attributed to the easterly flowing Leeuwin Current (Glover & Olsen 1985).

A survey of offshore fish in the Great Australian Bight, at depths of 400 - 1200m (Newton & Klaer 1991), has recorded 166 species of deep-sea fishes, recording new species and extending species distributions (Glover & Newton 1991).

3.3.6 Marine Invertebrates

The rich diversity of ascidians and other invertebrates in the Great Australian Bight region has been referred to on pp.14 - 19.

At greater depths, the continental slope of the mid-latitudes of the southern hemisphere is now documented as having a higher level of species diversity than areas of similar latitudes in the northern hemisphere (Poore *et al.* 1994). A survey of the crustacean isopod fauna from the Australian southeastern continental slope between 200 and 3150 m depth found a very rich fauna which is largely undescribed.

4 COMMERCIAL VALUES

The current commercial use of the Great Australian Bight Marine Park is minimal. There is at present no mineral or petroleum exploration or development proposals within the boundaries of the Marine Park. Commercial fishing activities are restricted to a scalefish industry concentrating on Shark gillnetting and several licensed Southern Rock Lobster fishers. There are presently no known marine-based development or aquaculture proposals within the area of the Marine Park.

4.1 Commercial Fisheries

Commercial fisheries within State waters come under the jurisdiction of the *Fisheries Act 1982* administered by PISA (Fisheries). The industry is represented by the South Australian Fishing Industry Council Incorporated (SAFIC). SAFIC is the recognised peak fishing industry body in South Australia, and represents all licensed fishers and fish processors in South Australia. SAFIC's principal role is to facilitate fisheries management within sectors, deal with issues affecting more than a single fishery and act as an information conduit between fisheries in South Australia.

Commercial fisheries within the area include Southern Rock Lobster fishing, Shark gillnetting and some limited Mulloway and Australian Salmon fishing. Such activities are appropriate where managed in an ecologically sustainable manner. In South Australia, commercial fisheries are primarily managed under provisions of the *Fisheries Act 1982* and through a system of Fisheries Management Committees.

The following commercial activities are undertaken within or within close proximity to the area proposed for the Great Australian Bight Marine Park:

Scale fishery

During 1989 - 90, 29 commercial licence holders (made up of Marine Scalefish, Restricted Marine Scalefish and Northern Zone Rock Lobster licence categories) took marine scalefish from the waters between the Western Australian-South Australian border (129˚ 00' East) and Point Sinclair (133˚ 00' East) (Jones 1991). On average, licence holders fished 20% of their effort in this region, however, for almost half of these fishers, more than half of their effort was expended in the area of the Marine Park.

Large mesh gillnetting (>15 cm mesh) was by far the most important method of capture, followed by handlines and rod and line (Jones 1991). The main species taken in inshore (<50 m) waters were Gummy (*Mustellus antarcticus*) and Bronze Whaler (*Charcharinus brachyurus*) sharks, Sweep (*Scorpus aquepinnis*), Mulloway (*Argyrosomus hololepidotus*) and Australian Salmon (*Arripis truttaceus*), and in offshore waters, School Shark (*Galeorhinus galeus*), Ocean Leatherjackets (*Nelusetta ayraudi*) and Deep Sea Trevalla (*Hyperoglyphe antarctica*) (Jones 1991). This fishery also includes such species as Pilchards, Whiting, Tommy Ruff, and Redfish.

Records indicate that pregnant School Sharks move from south-eastern Australia to the Great Australian Bight for the period of gestation, and then return eastwards to give birth.

The catch-effort for the area within the region of the Great Australian Bight Marine Park is illustrated in Figure 16. These data relate specifically to fishing zones 1, 2 and 3 as illustrated in Figure 17. The majority of this catch (90%+) is made up of Shark. Large mesh gillnetting (>15 cm) was by far the most important method of capture (Jones 1991). Marine scalefish catches have varied from 28 tonnes in 1983/84, to a maximum of 143 tonnes in 1991/92. Increases in shark and marine scalefish catches in recent years (ie since 1991/92) with the Great Australian Bight region, are not apparent.

Extensive pilchard fisheries occur in bays to the west of the Great Australian Bight (Esperance, Albany, WA), whilst in SA, operations target areas east of the Bight. In 1992/93, the total allowable catch (TAC) for the pilchard fishery (3450 tonnes) constituted half of the SA's commercial marine scale fishery.

Rock lobster fishery

Most of the present fishing activity for Southern Rock Lobster (*Jasus edwardsii*) is confined to the eastern sector of the proposed Great Australian Bight Marine Park, along rocky reefs east of Twin

Rocks (area 3, Figure 17). While fishing activity has increased within the area of the proposed Marine Park in recent years, particularly in 1993/94, fishing activity has traditionally been minimal and opportunistic, with effort and catch rates representing a small proportion of the total effort and total catch of Southern Rock Lobster for the Northern Zone Rock Lobster Fishery.

Due to the small number of fishers operating within the Great Australian Marine Park region and the confidential nature of these data, annual catch landings are not publicly available for the Lobster Fishery. However, between 1983/84 and 1986/87 the average catch per annum in the Marine Park region, ie. fishing areas 1, 2 and 3 (see Figure 17), was 0.41% of the total Lobster Fishery catch for the same period. Between 1986/87 and 1990/91 the average catch per annum was 0.49% of the total Northern Zone Rock Lobster Fishery catch for the same period.

The average catch of lobster between 1991/92 and 1994/95 for the Marine Park region was 2.69% of the total catch for the same period. In 1993/94 there was a significant increase in the number of fishers operating in the Marine Park region and their reported catch of 44 314 kilograms represented 4.47% of the total catch.

Deep sea trawl fishery

The Great Australian Bight trawl fishery is a Commonwealth managed fishery which extends from Kangaroo island off South Australia, to Cape Leeuwin in Western Australia, a distance of over 2 000 km. This fishery lies outside the Great Australian Bight Marine Park.

The southern boundary of the Great Australian Bight Trawl Fishery is the edge of the Australian Fishing Zone (AFZ) which extends to 200 nautical miles offshore. The northern boundary (31.52°S), mostly follows the 200m depth contour about 20-90 nautical miles offshore. Fishing activity in the Great Australian Bight Trawl fishery is currently confined to a fairly narrow margin off the continental shelf and slope, in depths of less than 1 200 m, mostly within the 100 - 200 m depth zone (Bureau of Resource Sciences 1993).

Data from the Great Australian Bight Trawl Fishery Logbook database indicate that species caught at depths less than 200 m (ie. the continental shelf) comprise mostly Deepwater Flathead (*Neoplatycephalus conatus*) and Bight Redfish (*Centroberyx gerrardi*), while at depths greater than 200 m (ie. the continental slope), Orange Roughy and various Oreo Dories (family Oreosomatidae) are the main species. The slope fishery has contracted in recent years and in 1994, yielded the lowest catch on record (Bureau of Resource Sciences 1994).

Southern Bluefin Tuna

The Southern Bluefin Tuna (*Thunnus maccoyii*) fishery is a Commonwealth managed fishery. Southern Bluefin Tuna spawn in the Indian Ocean, south of Indonesia, and move south along the western seaboard of Australia, and easterly along the south coast of the Australian continent, where juvenile fish of 1 to 4 years of age school seasonally in the surface waters off southern Australia. Southern Bluefin Tuna mature at approximately 8 years of age and may live as long as 40 years (Bureau Resource Sciences 1995). Because of their long exposure to fishing activity prior to spawning, the species is highly vulnerable to overfishing, and then slow to recover.

In recent years an active purse seine and pole fishery for this species has been confined to the South Australian sector of the Great Australian Bight (Jones 1991). Prior to this, effort was more evenly spread throughout the waters of the Great Australian Bight. The reason for the contraction of the fishing area has been output controls in the fishery through quota restrictions (Jones 1991).

With the shift away from longline fishing to purse seining most fish are now taken south, below 32°S and east of the Great Australian Bight. This fishery operates outside the limits of the South Australian waters, with no recorded catch of Southern Bluefin Tuna reported within boundaries of the Great Australian Bight Marine Park (see Table 5).

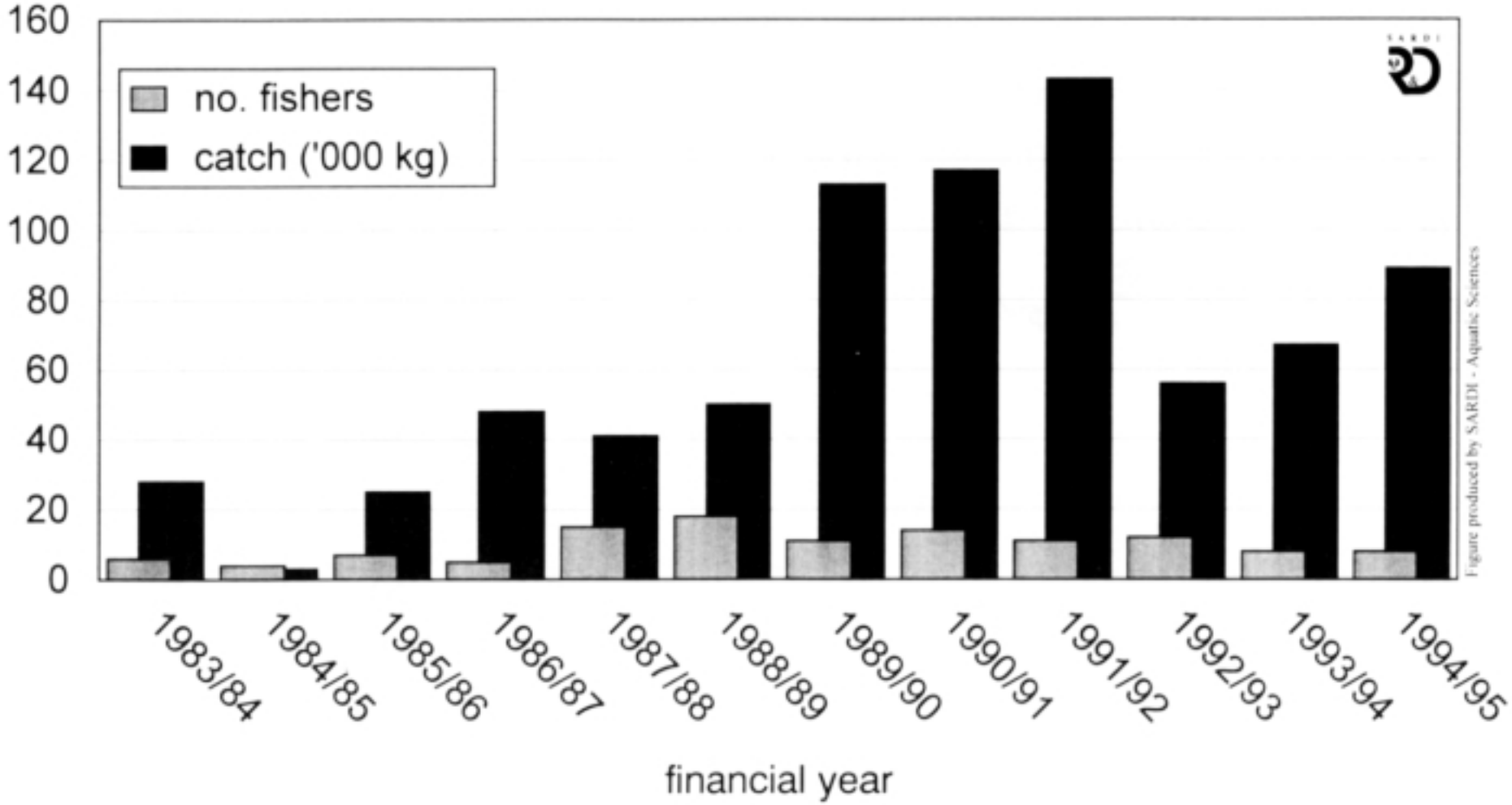


Figure 16: Annual catch of marine scalefish species in the Great Australian Bight (i.e. fishing zones 1, 2 and 3) from 1983/84 to 1994/95.

Figure 17: Marine fishing zones in the Great Australian Bight.

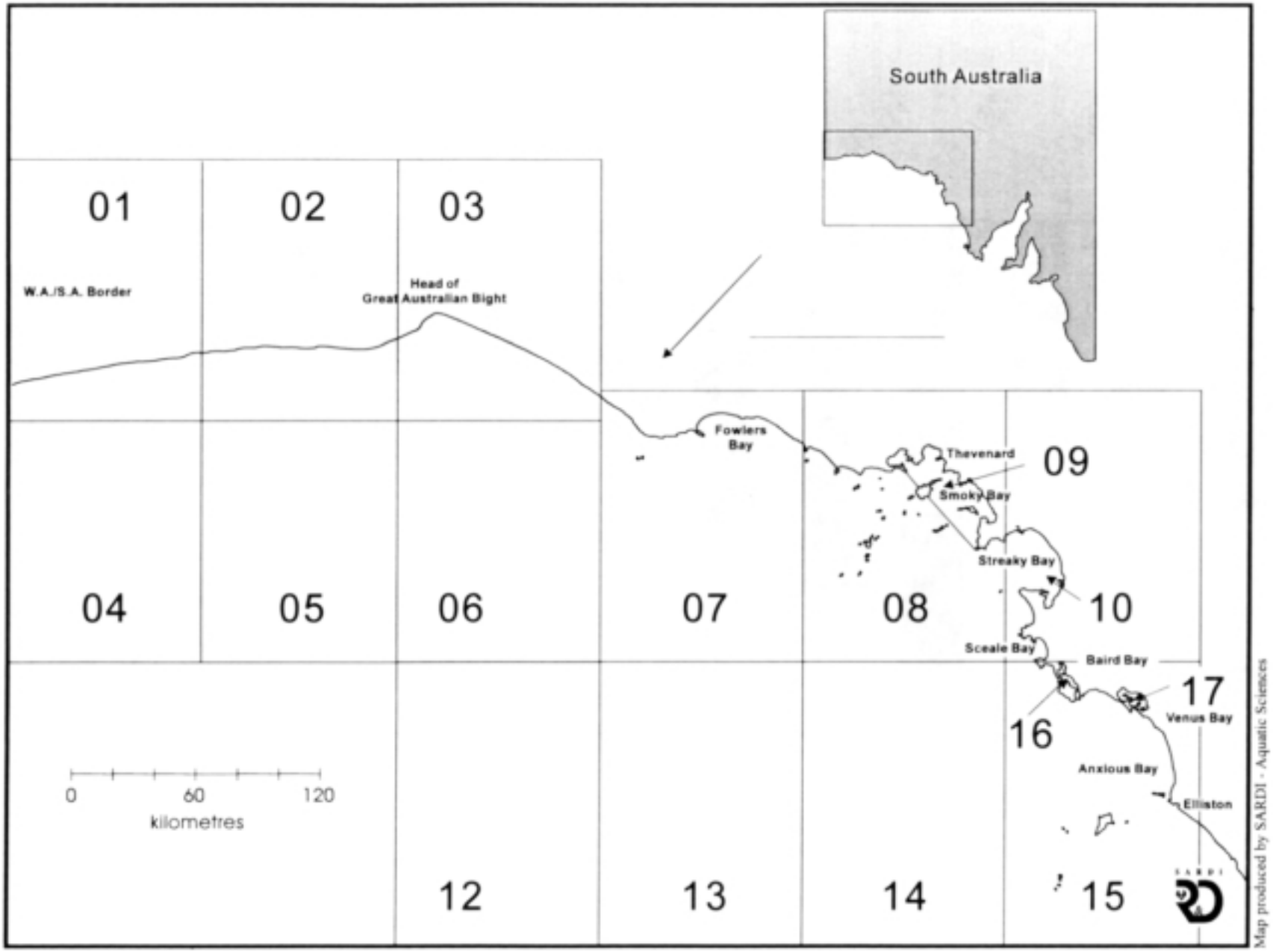


Table 5 Annual catch of Southern Bluefin Tuna in the Great Australian Bight region (GAB), north of 31˚55'S, and from 129˚00' E to 132˚00'E, from 1979-1995 (source: Australian Fisheries Management Authority (AFMA)).

Season	SA Catch (tonnes)	GAB Catch (% SA Total)	130˚55- 132˚00'E# (% SA Total)
1979/80	6 855	nil	nil
1980/81	9 877	70 (0.71)	70 (0.71)
1981/82	12 748	64 (0.50)	64 (0.50)
1982/83	13 831	46 (0.33)	41 (0.29)
1983/84	10 419	26 (0.25)	26 (0.25)
1984/85	11 271	nil	nil
1985/86	12 088	11 (0.09)	nil
1986/87	10 029	83 (0.83)	58 (0.58)
1987/88	9 849	592 (6.01)	2 (0.02)
1988/89	4 872	873 (17.92)	6 (0.12)
1989/90	4 199	706 (16.81)	7 (0.17)
1990/91	2 588	nil	nil
1991/92	1 935	nil	nil
1992/93	1 506	nil	nil
1993/94	1 970	nil	nil
1994/95	2 872	nil	nil

Data Source: Domestic and JV vessels (AFMA)

Area from existing GAB Marine Park Whale Sanctuary, south to 31˚55'S, and east to eastern border
of GAB Marine Park (132˚00'E).
* There was no recorded catch of Southern Bluefin Tuna within the State waters of the Great Australian Bight Marine Park.

4.2 Commercial shipping

It appears from available information (principally the Marine Rescue and Coordinating Centre in Canberra) that no commercial shipping passes through the State waters of the Marine Park. It appears also that no commercial shipping would enter the proposed Commonwealth waters of the Marine Park.

4.3 Mineral and petroleum exploration and extraction

There are no known hydrocarbon or mineral deposits within the area of the proposed Great Australian Bight Marine Park. Nearly all economic geological interest in the Great Australian Bight region has been centred on the petroleum potential of the Duntroon and Polda basins (Hill 1994), outside the boundaries of the Great Australian Marine Park. More recent activity has focussed on the mineral potential of the Coompana Block, the Mallabie Depression and the Gawler Craton, especially its western boundary (Edyvane & Andrews 1995). All these tectonic features border and probably extend into the Great Australian Bight region.

The prospectivity over the area is probably poor (for hydrocarbons) but requires seismic and other detailed data before a more conclusive assessment can be made. Currently there are no proposals to carry out any exploration within the Marine Park area (Figure 18). According to Mines & Energy, the geology of the region presents a variety of mineral exploration opportunities.

5 RECREATION AND TOURISM VALUES

The outstanding natural beauty of the Great Australian Bight region attracts large numbers of visitors seeking a diversity of recreation experiences. Most of these gain access to the perimeter of the Marine Park from the land.

Little is known of sea-based access except for the commercial fishing industry. There are presently no facilities for launching boats along the entire coast of the Great Australian Bight Marine Park. It is possible to launch vessels from Coymbra (Cumbera) Beach and Merdayerrah Sandpatch, weather permitting, but there is little information on the level of use.

5.1 Whale watching

The Head of the Bight region is a major site for whale watching from the land, particularly at a site known as Callosity Point. The area affords spectacular close views of Southern Right Whales calving, nursing and mating, often within 100 m of shore. These views are enhanced by the unspoiled coastline, which provides unique cliff-top whale-watching opportunities.

The issues of access and management of the whale-watching at the Head of the Bight involve the Yalata Aboriginal community who lease the area from the Aboriginal Lands Trust. At present visitors are required to obtain a permit from either the Yalata Roadhouse or the ranger station at White Well. The permit system provides guidelines for camping and attractions within the region and provides an opportunity for information on visitors to be collected.

For visitors to the Head of the Bight, whale-watching is an important activity, but is not the only motivation for visiting. From a recent visitor survey of the Head of the Bight region Reid (*in press*) made the following observations. Only a quarter (24.1%) claimed whale watching as the sole purpose of the journey and several were unaware of the opportunity until they arrived. Few had previously experienced whale-watching at the Head of the Bight (8.5%). Despite prior interest in whales and the coastal environment, many seemed unaware that they could pursue these interests at the Head of the Bight. In general, the average visitor is aged over 50 (56.8%), from South Australia (38.9%) is likely to belong to a conservation group (30.4%) and has at least a secondary education (33.5%). Many visitors travelled with a spouse (56.3%) or other family members (37.4%) and had generally included the Bight as a stop-off while crossing the Nullarbor on the way to some other destination.

The most frequent source of information for visitors about whale watching at the Head of the Bight was word of mouth (68.7%), rather than any promotional effort. The spontaneity of their visits and perhaps their unpreparedness for the lack of facilities may partially explain why visitors only spend on average 3.6 hours whale watching at the Head of the Bight. For 40% of the visitors, their introduction to whale-watching occurred at the Head of the Bight. There were complaints relating to infrastructure and the rough access road, but visitors were notably pleased with other aspects of the whale watching experience. Most were driven by curiosity and simply the desire to see whales (94.2%) and 96.6% were pleased to satisfy this one aim. A total of 67.3% of respondents were particularly pleased with the number of whales; 10% ranked the experience as the best part of their trip.

5.2 Recreational fisheries

The major recreational fishery within the proposed Great Australian Bight Marine Park is a shore line fishery targetting two species—Mulloway (*Argyrosomus hololepidotus*) and Australian Salmon (*Arripis truttaceus*). Fishers include members of fishing clubs, organised fishing safaris and four-wheel-drive fishing enthusiasts (Jones 1991). Major fishing areas occur east of the Head of Bight and at Coymbra. Although total recreational fishing effort has not been quantified in the region, its importance for local and regional tourism on the far west coast is well-accepted.

Mulloway is an important recreational and commercial fish species in South Australia. Although no detailed scientific literature is available on the biology of this species in South Australian waters, evidence from tagging and genetic studies on Mulloway suggests that there are two populations one in eastern waters centred around the Coorong and a smaller population centred at the Head of the Great Australian Bight (Hall 1986). Observations from fishers in the latter area indicate a

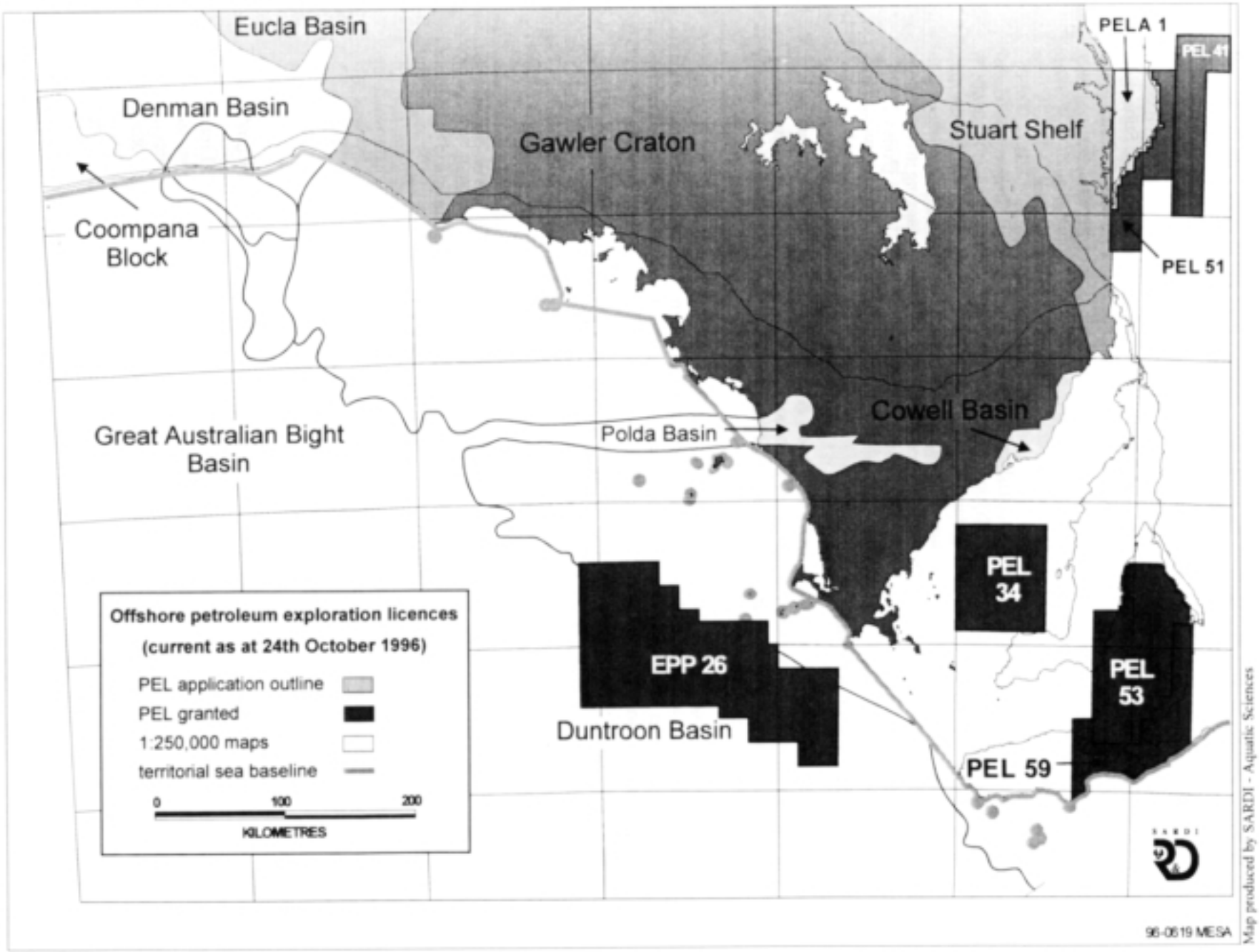


Figure 18: Location of major sedimentary basins and potential petroleum prospects in the GAB region (from MESA).

westward movement of fish in the spring to summer period and a reverse movement in the autumn to winter period. Several management measures have recently been put in place with the special aim of conserving the Mulloway stock in the area (see Jones 1991).

Australian Salmon comprise a single stock with one known spawning location near the south western coast of Western Australia. In South Australian waters the population comprises juveniles, found mainly in the sheltered waters of the Coorong, the gulfs, and the west coast bays. Sub-adults are found on medium to high energy coast lines (Cappo 1987). The South Australian sector of the Great Australian Bight is the last area in the eastern region of the Bight where relatively slower growing adult fish are caught before migrating to the spawning area and fishing grounds in Western Australia (Cappo 1987).

In an investigation of the Australian Salmon fishery in South Australian waters (between 1984 and 1987), recreational fishers comprised both local fishers (Ceduna) and visitors from as far away as the northern Spencer Gulf cities and Adelaide (Cappo 1987). The study revealed that fishers may travel distances of up to 950 km because of the relatively high catch rates and large size which provide the expectation of capturing high quality sport fish. Some preliminary tagging investigations on Mulloway in this region (Hall 1986) reveal a similar potential for sport fishing (Jones 1991)

5.3 Other visitor activities

Decisions on the management of recreational impacts depend upon assessments of factors such as the location, type and frequency of the activity, the numbers involved, the experience sought by visitors, conflicts between users, and the risk and nature of the potential damage to an area's natural, cultural and heritage values.

Marine Park management (and management of the adjacent coastal lands) will aim to accommodate different levels of use in the parks, rationalise competing uses and provide opportunities for a wide range of activities while ensuring that the scenic, natural, cultural and heritage features which attract many visitors are preserved.

The management of land-based activities including boating, diving, swimming, camping activities is dependent on management of adjacent land areas.

5.4 Visitor information

Visitor understanding, enjoyment and commitment is enhanced by the provision of appropriate information. This should be accessible to all visitors, whether they travel by land, sea or air. Community understanding is important to foster effective support for management and protection of natural and cultural resources.

At present there is very little information provided for visitors relating to the whale watching activity that takes place at the Head of the Bight.

6 CULTURAL VALUES

6.1 Aboriginal history *

The Aboriginals call the Nullarbor plain Undiri and think of it as a bare hostile landscape inhabited by subterranean spirits. In the past the Aboriginal people lived on its southern and northern fringes and avoided the waterless, treeless interior. Small bands of Aboriginal people may have used unusually good weather to explore the heartland of the Nullarbor plain. Population density was probably low, and exploration of the vast limestone plain must have been sporadic.

The ability of the environment to support more permanent populations has improved over the last 10 000 years. Hunting and gathering focused on the coast and the hinterland where kangaroo, wombat and small marsupials were exploited. These people, and descendants of the cave miners at Koonalda, were identified as the Mirning (Tindale 1974). The Mirning occupied the southern portion of the Nullarbor plain and were coastal people. Their territory extended from White Wells near the Head of the Bight into Western Australia (see Figure 19).

To the east of the Mirning were the Wirangu. Tindale (1974, p. 219) places this group within a large group within a territory extending from the Head of Bight, north to Ooldea, and east to the Gawler Ranges and Streaky Bay. The location of these two groups was clearly defined in most historical sources, although different territorial interpretations were also recorded. To the north of the coastal people were the Ngalea, Kokata and Pindini. They inhabited the Great Victorian desert and belonged to the Western Desert Cultural Bloc. These groups together with the Pitjantjatjara to the north had close relationships. They shared the valuable waters of Ooldea in times of drought, and had close contact with the Nullarbor people.

Aboriginal subsistence was dominated by seasonal weather patterns. The inhabitants were described as living on the coast throughout the spring and summer travelling inland when the sea was rough and cold and the inland rock holes were full. Much of the coastline was inaccessible because of the cliffs and occupation focused around fresh water soaks at the Head of Bight, Eucla and Merdayerrah Sandpatch. Coastal resources included seals, shell fish, fish, birds, wombats and other large game.

In the winter, kangaroo, turkey and emu were abundant (Bates 1938, p. 140). People lived around shallow limestone rockholes and moved back to the coast as the weather warmed and the surface water evaporated. The people were essentially meat eaters, adding snake, lizard, bandicoot, wallaby and wombat to their diet.

With the exception of the saline watertable of some of the larger limestone caves the Nullarbor contains no known permanent supplies of water. Temporary supplies in rockholes were used on the plains (Figure 20) and these were connected by Aboriginal pathways or dreaming trails which formed major highways across the Nullarbor Plain.

Contemporary Aboriginal interest should be subject to further investigation. Such work should document not only traditional associations with and use of the marine environment, but also determine Aboriginal views as to the future use and management of the seas within the Marine Park.

6.2 Non Aboriginal history and development **

Europeans first saw the Nullarbor from the sea in the seventeenth century and called it Nuytsland but shied away from the formidable cliffs. Early overland visitors to the Nullarbor were interested in its grazing potential. Explorers Eyre and Warburton reported the Nullarbor Plain unfit for settlement while others reported enthusiastically about the grazing opportunities. Pioneers who attempted settlement of the area found limited opportunities. However, in the southern Nullarbor, pastoralists settled in areas where palatable borewater was located.

Yalata Station near Fowlers Bay was established in 1858, Mundrabilla Station was established in 1871, Moopina in 1873, Madura in 1876 and Balladonia in 1880. A relatively small area is now occupied by pastoral leases and none of the proposed Great Australian Bight Marine Park borders pastoral leases.

* from Cane and Gara (1989)

** from McKenzie and Robinson (1987)

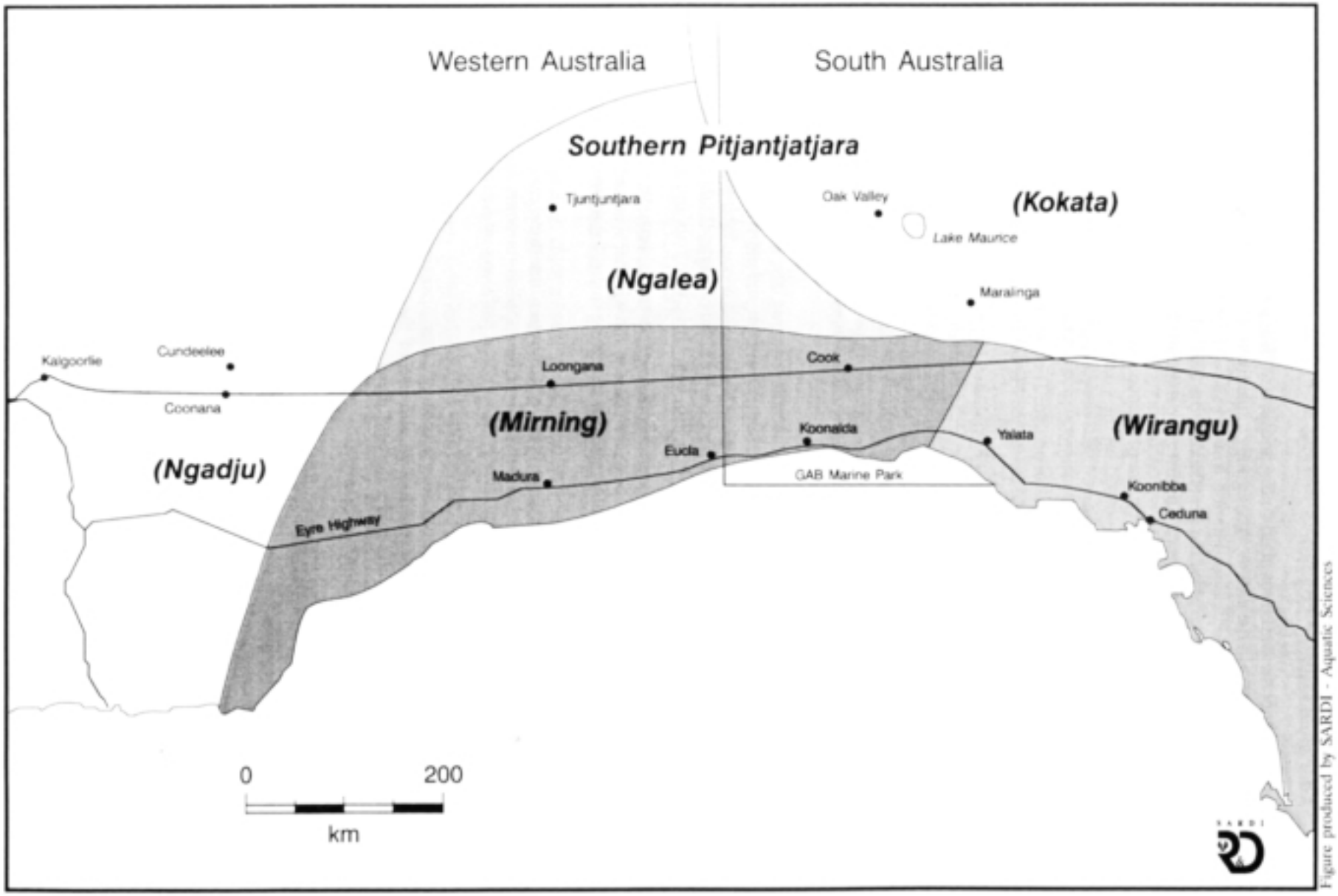


Figure 19: Aboriginal lands pre-1850 (from Tindale 1974, in Cane 1992).

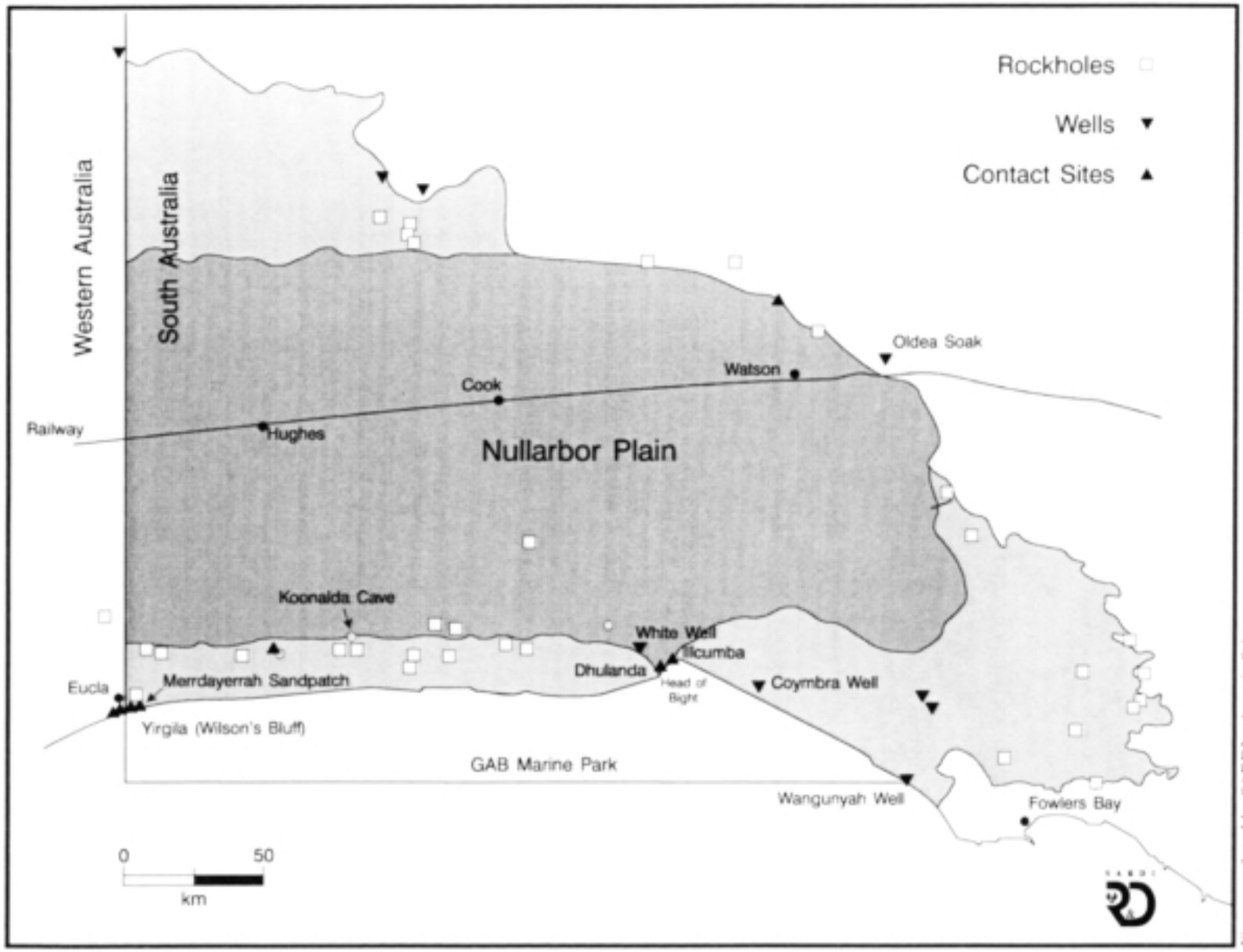


Figure 20: Waterholes and contact sites on the Nullarbor Plain (from Cane 1992).

The overland telegraph was commenced in 1874 and Eucla was declared a town site in 1885 and was for many years the only township in the Nullarbor region. The telegraph line was followed by a rough track and this route was upgraded in 1941 and became the Eyre highway.

A railway from east to west across Australia was a condition of Federation in 1901 and the line passes through the Ooldea soak.

There is little or no available information regarding historical use of the marine portion of this area. Use by whalers was limited and is discussed under *Commercial Whaling*, p. 29.

7 SCIENTIFIC RESEARCH

Research and monitoring in the Marine Park will provide good opportunities for observing the affects of protection and utilisation of species. Tertiary institutions, industry and community groups will be encouraged to undertake research and monitoring. In particular the following aspects could be given consideration in developing such programs.

General

- research of an applied nature to assist with ongoing management of the Park and the species occurring within it.
- investigation of contemporary Aboriginal interest in the Marine Park, including continuing traditional associations and future use.

Southern Right Whales

- develop baseline assessments of normal patterns of behaviour and movement, to provide a baseline against which to assess patterns in areas where whales are subject to potential stresses (Objective 14.7, *Southern Right Whale Recovery Plan*);
- assist the development and maintenance of a National Catalogue of individually-identified Southern Right Whales for long-term use by researchers and managers (Objective 14.12, *Southern Right Whale Recovery Plan*);
- research and monitor spatial and temporal use of the Marine Park by the migrating Southern Right Whale population; and
- research on potential vessel/whale interaction in the region (ie. acoustic disturbance, vessel strikes)

Australian Sea Lions

- conduct a systematic and comprehensive survey of the Sea Lion population in the Great Australian Bight Region
- monitor Sea Lion colonies each breeding season to determine pup production in the Great Australian Bight Region
- investigate the genetic relatedness of the Australian Sea Lion across the species range
- investigate the levels of interaction and by-catch of Australian Sea Lions in fishing operations in South Australia
- investigate the feeding ecology and foraging behaviour of Australian Sea Lions, including the use of nearshore waters by weaning and recently weaned pups (using time-depth recorders and radio transmitters, and stomach lavage or emetics)
- assess the marine biota adjacent to Australian Sea Lion breeding colonies to determine the availability and probable use of prey resources by various age classes of sea lions.
- determine the feeding location, and type of prey of Australian Sea Lions in the Great Australian Bight.

Marine Biodiversity

- expand knowledge of marine biodiversity of the Great Australian Bight Marine Park
- identify indicators of environmental change
- develop programs for monitoring population changes

Commercial Fish Species

- assess value of closed Whale Sanctuary as a restocking area for Southern Rock Lobster
- assess value of closed Whale Sanctuary as a restocking area for the Shark fishery

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GLOSSARY

aquaculture	the farming of organisms in freshwater, marine or estuarine aquatic environments (includes mariculture).
asteroid	a type of echinoderm; starfish.
benthic	referring to all life living at the bottom of the sea; either fixed or capable of crawling on, burrowing through or swimming over the sea floor.
biodiversity	biological diversity; the variety of all life forms existing in the terrestrial, aquatic and marine environments. Includes the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part.
biota	the total plant and animal life of a region.
bryozoa	colonial animals that can build calcareous structures; lace corals.
carrying capacity	the level of use or activity beyond which effects or impacts (for example, social, ecological and cultural impacts) exceed acceptable levels.
calcarenite	limestone composed of coral or shell sand or sand derived from erosion of older limestone.
cephalopod	a type of marine mollusc e.g. squid, octopus or cuttlefish.
conservation	the management of human use of that part of the earth that supports living organisms so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and aspirations of future generations; the maintenance of conditions or features in a sound or unimpaired state.
copepod	a component of plankton; a minute crustacean.
cultural heritage	knowledge, places and things, including those made or changed by humans, that have aesthetic, historic, scientific, social or spiritual significance or other special value for future generations as well as the present community.
demersal	fish and other organisms that live on or near the sea floor and live on benthic organisms.
ecology	study of inter-relationships between living organisms and their environment.
ecological sustainability	use, conservation and enhancement of community resources so that the ecological processes upon which life depends are maintained.
ecosystem	an assemblage of plants, animals and micro-organisms and their physical environment interacting as an ecological unit.
ecotourism	tourism based on visiting relatively undisturbed natural areas, which is non-damaging and contributes directly to the continued protection and management of the areas used.
endangered species	species in danger of extinction and whose survival is unlikely if the factors threatening their survival continue operating.
endemic	unique to an area or region; found no where else.
environment	all aspects of the surroundings of human beings, whether affecting human beings as individuals or in social groups.
estuarine area	the lower course of a river or stream forming a semi-enclosed water body connected to the sea, within which tides have an effect and where fresh and saline water mix.

exotic species	a species that is not native to a region, especially one that does not originate in Australia.
foraminifera	mostly marine single-celled animals, usually microscopic, that build calcareous cell coverings.
gyre	a circular or spiral movement or circulation.
habitat	a place in the environment usually occupied by a particular organism or a group of organisms.
infrastructure	basic framework supporting an organisation, community (for example buildings etc, roads, energy, water, transport and telecommunications) or operational system (for example, an information network).
integrated management	a long-term approach that, while retaining the benefits and efficiencies of sectoral management and associated expertise, also brings together the considerations, interests and experts of all sectors.
mariculture	farming of aquatic organisms in marine and estuarine environments.
marine	of, or relating to the sea.
Marine Protected Area (MPA)	any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment, i.e. Aquatic Reserve, Marine Park, Sanctuary, etc.
natural processes	environmental processes that are not the product of human activity (for example, tides, currents, cyclones and wind erosion).
nm	Nautical mile. A unit of measurement used in marine navigation equal to 1852 m originally defined as one minute of latitude.
Ocean Rescue 2000	a ten year Commonwealth conservation and management program for Australia's marine environments; the program aims to bring together expertise to assist in the development of long term plans and strategies to ensure the protection and sustainable use of Australia's marine environment.
pelagic	marine organisms which live free from direct dependence on bottom or shore.
phytoplankton	microscopic plants that float on or drift in water.
resource	biological, mineral or other material, (natural or not) of the environment, including permanent or temporary combination or association of materials.
resource use	includes proposed use and, in relation to a resource, use for, or by way of, conservation or development, and use of the resource before, during or after any processing.
rorquals	'grooved whales'; belonging to the family *Balaenopteridae,* including Minke whale, Bryde's whale, Fin whale, Blue whale, Humpback whale.
sectoral management	management of separate resources or activities, such as fisheries, forests and agriculture, without coordination of management mechanisms.
terrestrial	of, or relating to the land.